Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

FEBRUARY, 1948

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DETROIT

ROLLS FOR RAILS

RAIL ANCESTRY

1630—Newcastle, Eng.—Wooden rails protected at curves and on grades by thin malleable iron plates.

1737—Whitehaven, Eng.—Continuous cast iron strips on wood stringers.

1767—Coalbrookdale, Eng.—Cast iron edge rails.

1776—Coalbrookdale, Eng.—Cast iron flange rails.

1789—Derby, Eng.—Jessop cast iron fish belly rail for flanged wheels.

1825—Stockton & Darlington R.R., Eng. —Birkinshaw rolled iron fish belly rail.

1831—Camden and Amboy R.R., N. J. —First "T" rails.

1833—Allegheny Portage R.R., Pa.— Clarence rail.

1834—Baltimore and Ohio R.R., Washington branch—"H" or double-headed rail.

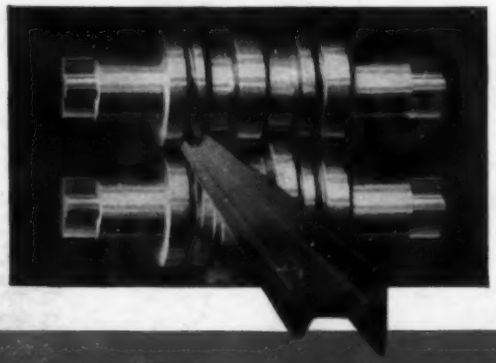
1844—Mt. Savage, Md.—First iron "T" rails rolled in America.

1865—First Bessemer steel rail rolled in this country by Captain Ward's North Chicago Rolling Mills.

1867—Johnstown, Pa.—First steel rails rolled "in the course of regular work" in America.

Modern rail mills prefer these Phoenix rolls:
For roughing stands: Phoenix "A" Alloy Steel.
For intermediate stands: Phoenix Metal and Phoenix "K" Alloy Iron.
For finishing stands: Phoenix Special Rail Finishing Alloy Iron.
This assures longer roll life, smoother rail surfaces, and *less cost per ton of rails rolled.*

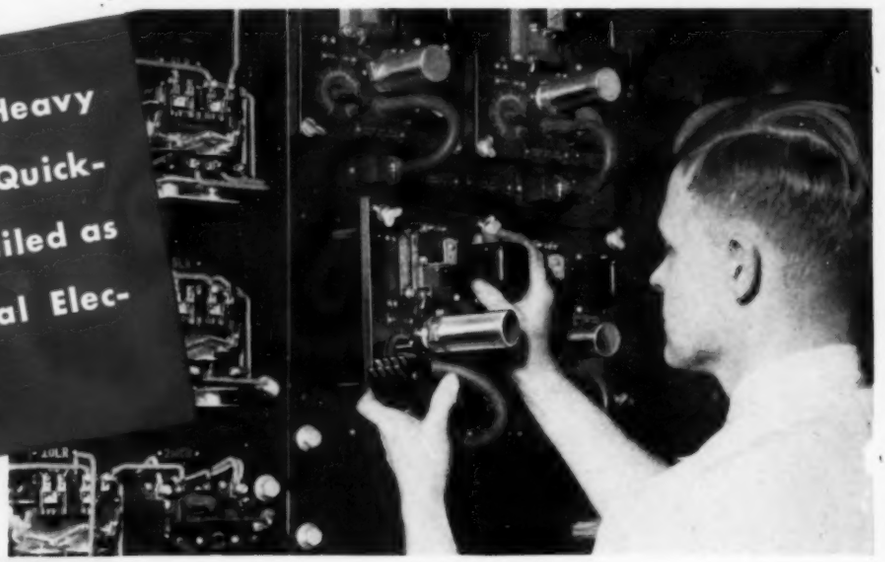
PITTSBURGH ROLLS
Division of Blaw-Knox Company
Pittsburgh 1, Pennsylvania

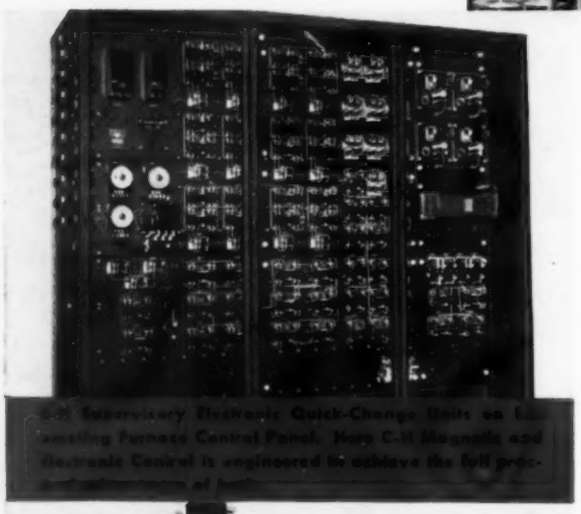


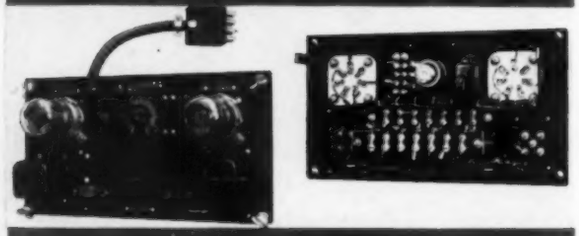
PITTSBURGH ROLLS P.R.W

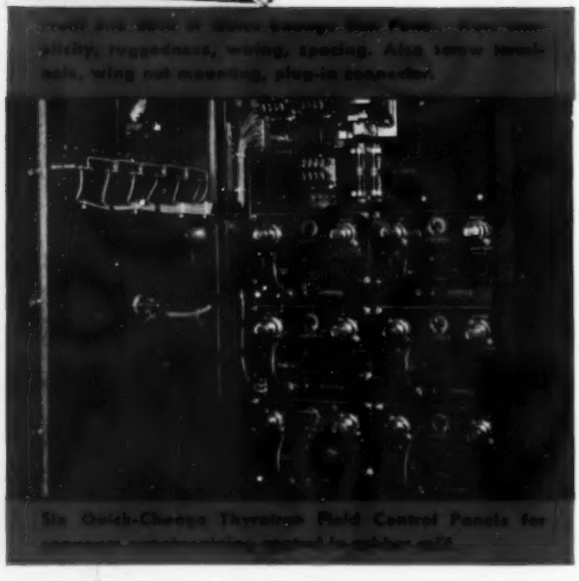
Now . . . *Electronics to Mill Standards*

New Cutler-Hammer Heavy Duty Construction and Quick-Change Unit Panel Hailed as Outstanding Industrial Electronics Contribution.









To the public, industrial electronics is a miracle maker. To many a mill's electrical department its practical application now becomes a reality.

Equipment has been fragile and complex . . . tough to install and remove, to test and inspect.

The Cutler-Hammer answer to mill duty electronics is a development now almost four years old, hailed by leading industrials as an outstanding contribution to practical electronics.

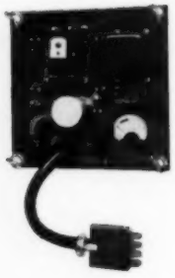
First of all, Cutler-Hammer engineers took electronic control equipment out of the radio receiver class and built it up to heavy duty industrial standards. Components are simple and rugged, minimum in number, better spaced, better wired and designed expressly for easy renewal of parts.

The introduction of the C-H Quick-Change Unit Panel now safeguards continuous mill operation plus other important advantages. Components are now mounted as a unit on a removable panel, assembled to the control board by means of captive wing nuts with plug-in connector. Inspection and instrument testing, back at the service bench is convenient because removing one electronic control panel and substituting a "spare" in its place is the matter of a moment.

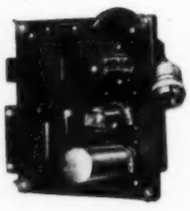
These sane and sound solutions are another product of Cutler-Hammer's "electronics-in-industry" experience dating back to 1916.

CUTLER-HAMMER, Inc., 1269 St. Paul Avenue, Milwaukee 1, Wis. *Associate:* **Canadian Cutler-Hammer, Ltd., Toronto, Ont**

CUTLER-HAMMER
ELECTRONICS
C-H



(at left) Typical C-H Mill Type Quick-Change Unit Panel for Furnace Control.

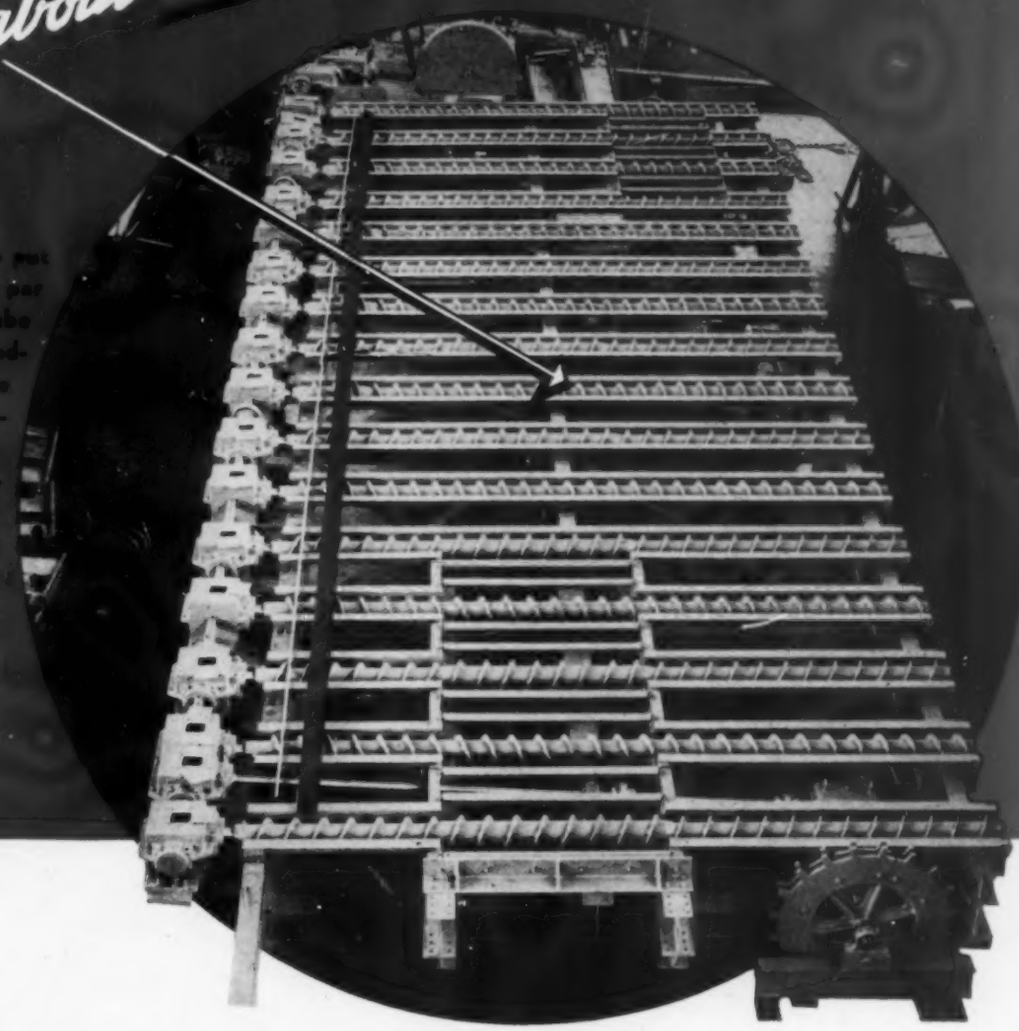


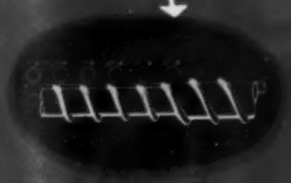
(at right) C-H Quick-Change Unit Panel for photo-electric limit switch used on automatic tube cut-off machine.

IRON AND STEEL ENGINEER, published monthly by Association of Iron and Steel Engineers, entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania, under Act of Congress March 3, 1879. $7.50 per year in United States, $8.25 Canada, $10.00 foreign countries. Volume 25, No. 2.

AT LAST! Somebody has done something about COOLING BED DESIGN...

● And here it is—a bed to put the cooling operation on a par with modern, high speed tube and pipe mills. Aetna-Standard's patented screw-type cooling beds offer advantages, removing problems common to the conventional chain-type operation. . . . Consult our engineers.





Here's the Basic Principle

Flanges of the turning screws roll tubes forward on tracks. Alternate turning directions of screw keep tube motion straight. Transverse motion is achieved by thickening shank of screws turning in desired direction so that tubes ride on and with the screws.

Patented Screw-Type Cooling Bed for Pipe and Tubing Has Multiple Advantages

1. Tubes fed to the bed at high speed are easily handled. Action of the screws tends to line up tubes and keep them straight and in order. Aetna-Standard's cooling beds will handle tubes of any length and diameters of 1/4" and up.

2. The screw action feature of tube alignment on the bed offers a further advantage. This same action has the tendency to straighten tubes that enter the bed with bows and bends. Another disadvantage of chain-type beds is thereby solved.

3 Complete control of tubes in motion is maintained. Transverse motion to either or both longitudinal directions of the bed is achieved by the design and motion of the screws. No auxiliary equipment is needed to feed tubes into saws for cropping. The same screws provide all directional control of motion.

4. Aetna-Standard's patented screw-type cooling beds are designed with a simplicity that not only speeds the operation, but reduces the maintenance requirements common to chain-type beds. Weigh the advantages and investigate this better method of cooling bed handling.

THE AETNA-STANDARD ENGINEERING COMPANY

YOUNGSTOWN, OHIO

ASSOCIATED COMPANY: HEAD WRIGHTSON & COMPANY, LTD., MIDDLESBROUGH, ENGLAND

OFF TO A GOOD START

Modern fabricators require sheet steel, precision-rolled to their specifications . . . and your selection of rolls is an important factor in meeting these exacting specifications, in turning out the ever-increasing tonnage that is in such demand.

In making rolls at National quality is paramount. Each operation is carried out with painstaking care . . . from laboratory control of raw materials through sound roll casting to precision finishing with the best of machine tools . . . so that they will give accurate and long-lived performance on-the-job.

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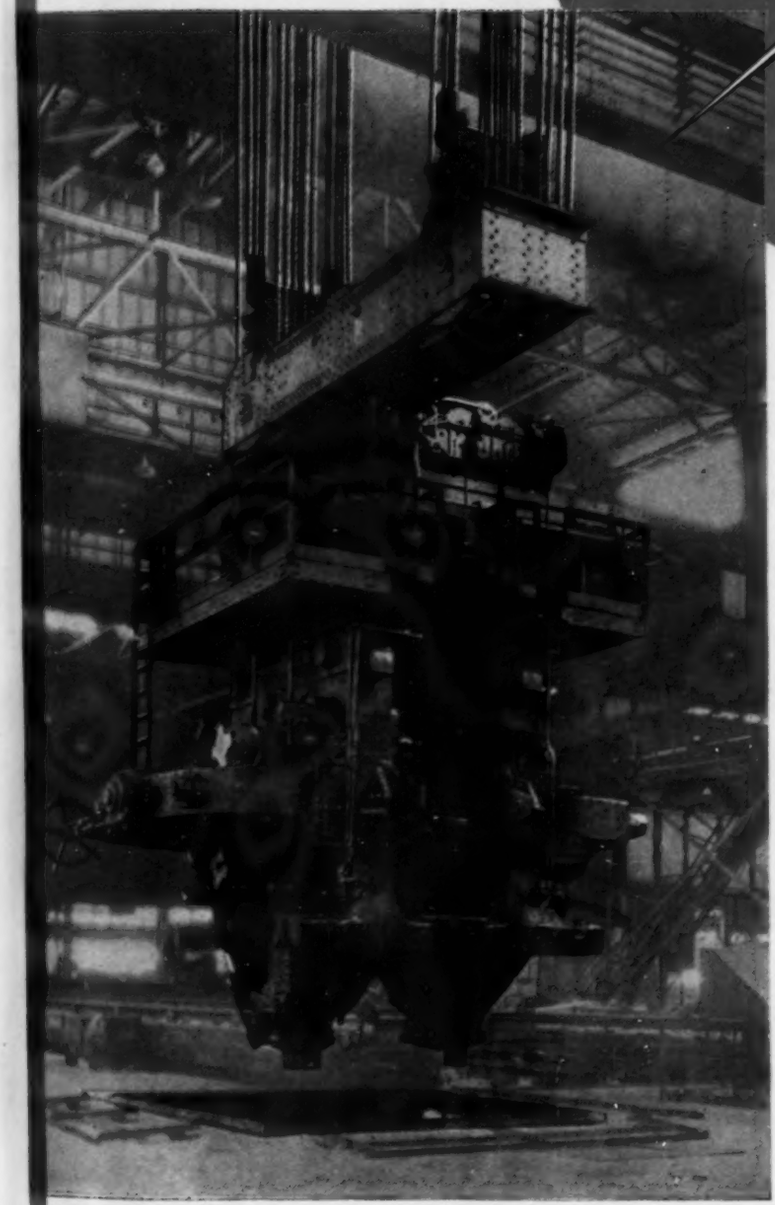
Alliance . . .

LEADER IN THE FIELD OF *Crane Design* FOR HALF A CENTURY



Shown here is a 300-ton, 4 Girder, Double Trolley ALLIANCE Crane. It has a 300-ton Main Hoist, a 40-ton, and a 5-ton Auxiliary Hoist.

● Are you handling heavy loads . . . moving slabs, ingots, hot metals, raw materials, or finished products? Then your plant needs sturdy, *efficient* Alliance cranes to handle these tough jobs safely, quickly, and easily. Developed by the world's largest builders of the world's largest cranes, Alliance equipment is built for long, rugged service . . . designed to give you unsurpassed, economical lifting power wherever it's needed in your plant.

Alliance specialists have studied materials handling problems for 50-odd years . . . have designed and developed thousands of cranes to handle all types of loads in many different industries. Let Alliance engineers show you how to maintain smooth-flowing production schedules with less cost, less effort, less maintenance work.

★

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SOAKING PIT CRANES • STRIPPER CRANES • SLAB AND BILLET
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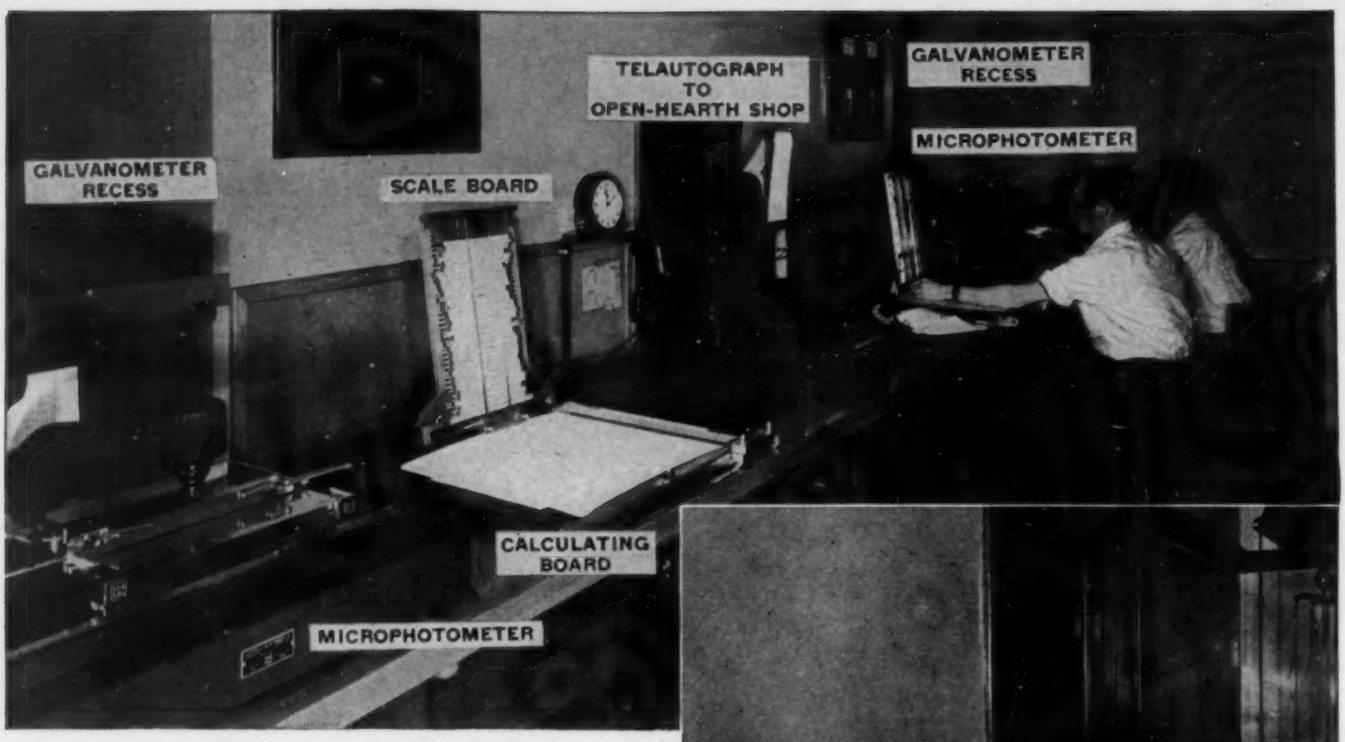


Above, Room containing Vincent-Sawyer Microphotometers in a steel mill's spectrochemical control laboratory. Here five men handle the control and heat analyses for the open-hearths and electric furnaces. The other three men on the shift stepped out of this picture so we could show the microphotometer at the left.

Steel Analyzed in Minutes With New Microphotometer

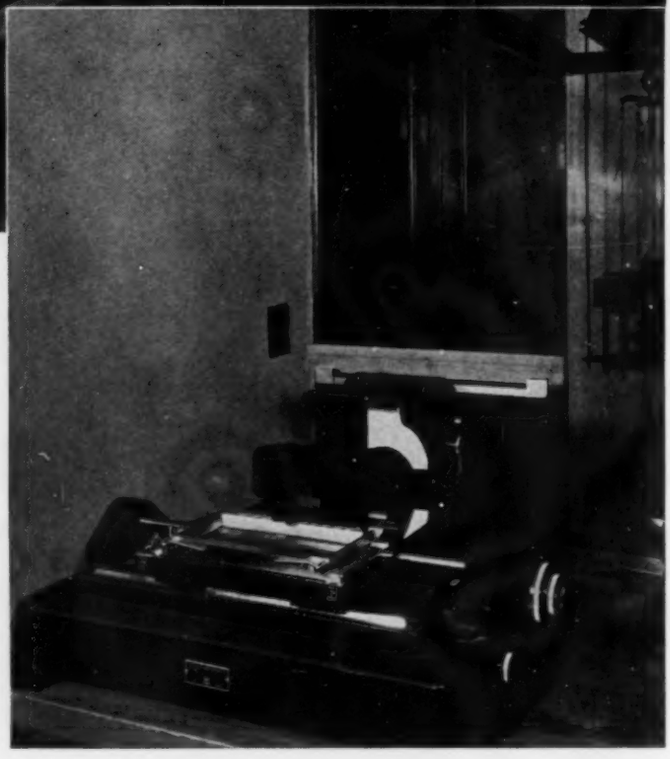
An average of 15 minutes from the time a sample is received until the composition has been reported — that is the speed of routine analyses in an Eastern steel mill.

This extra-fast analysis, accomplished with the L&N Vincent-Sawyer Microphotometer, enables open-hearth and electric furnace helpers to bring the analysis of each melt closely to specifications; cuts the total time per heat.

Samples from electric furnaces and open-hearths are sped by pneumatic tube to the laboratory, where exposures (spark or arc as required) are taken, developed and sent to the microphotometer room. An operator next measures densities of preselected spectrum lines with the microphotometer. Another operator translates density ratios into percentages of elements, and the foreman then examines the analysis and sends it by Telautograph to the open-hearth shop.

Designed for rapid, routine analyses rather than for research, the L&N Vincent-Sawyer Microphotometer has the following advantages in addition to speed:

1. Exceptional accuracy and stability. Positioning of the spectrum plate is rapid and highly precise. Photoelectric scanning is sharp and accurate. Indicator is an L&N Type HS Galvanometer whose high sensitivity makes an amplifier unnecessary; readings are free from pick-up.



Close-up view of Microphotometer and galvanometer assembly.

2. Easy and simple to use. Operation requires only a few simple, natural motions and a minimum of eye movement — important factors in reducing fatigue and error.

The instrument is described in detail in an 8-page folder which we'll be glad to send on request. Ask for Reprint E-90(1).

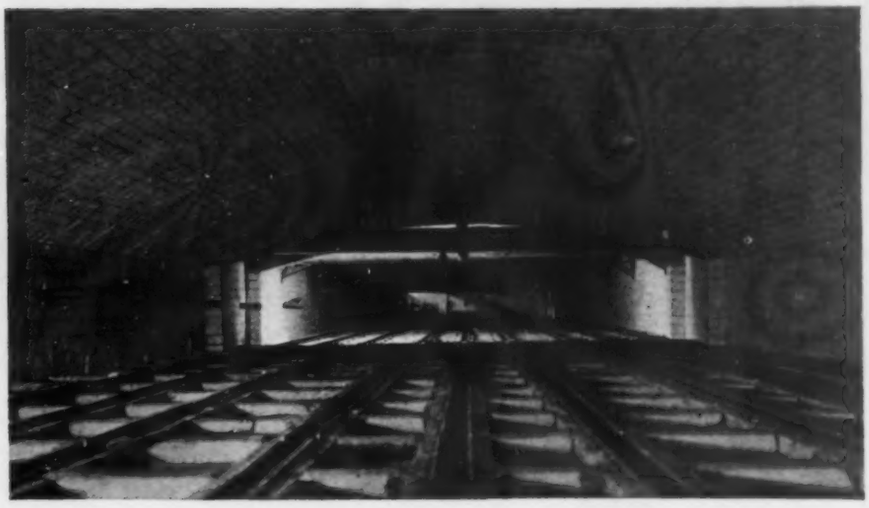
LEEDS & NORTHRUP COMPANY, 4942 STENTON AVE., PHILA., PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

Jrl. Ad E-90(4)

Photos courtesy Surface Combustion Corp.



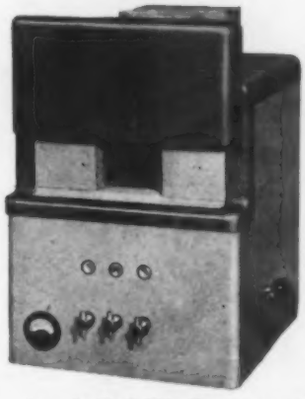
GIANT or DWARF

For lower operating costs, line your furnace with B&W Refractories

Minimizing maintenance and providing continuously superior performance are just two of the many ways B&W Refractories cut operating costs in all types of industrial furnaces—large or small.

In large malleableizing furnaces of the type shown above, the same B&W Refractories—after 11 years of continuous operation with high CO atmospheres—are still providing outstanding service, despite the added strain placed on them during the rigorous war years.

In small laboratory furnaces, accurate temperature control and the ability to perform precise pilot operations which can later be duplicated—are essential factors in holding down overall costs. Because of their superior insulating qualities, B&W Insulating Firebrick are widely used for this precision work.



Your local B&W Representative will be glad to show how the use of B&W Refractories may be profitable in your furnace—large or small.

R-291

B&W REFRACTORIES PRODUCTS

B&W 80 FIREBRICK • B&W JUNIOR FIREBRICK
B&W 80 GLASS TANK BLOCKS • B&W INSULATING FIREBRICK
B&W REFRACTORY CASTABLES, PLASTICS AND MORTARS

•

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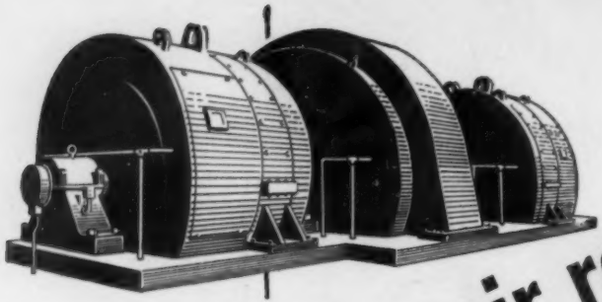
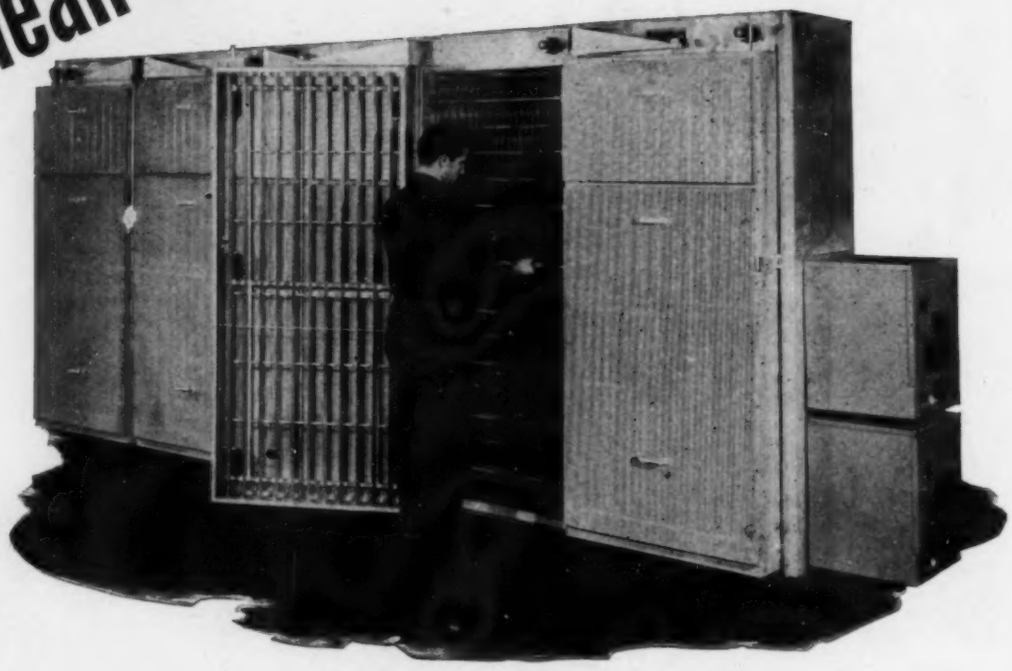


Where clean air returns a cool profit



COOLING mill motors—either by force ventilation or a recirculating system—introduces a serious air cleaning problem. All of the air used with forced ventilation or that portion required for make-up with recirculation must be cleaned. The nature and volume of dust created by steel mill operation makes it necessary to clean any outside air entering the motor room.

This emphasis on clean air has increased the interest in electronic precipitation for steel mill service. The Electro-Cell washable type electric precipitator has proved extremely satisfactory for steel mill applications. Dust, soot and smoke are removed from the air with the highest efficiency. Design featuring removal collector plates offers a choice of maintenance methods—removing cells for servicing in special cleaning tank, manual washing and re-oiling in place or automatic cleaning in place without interruption of operation. Other features such as sectional construction and full-height hinged ionizers make for simplified installation and greater safety.

Whatever your motor cooling requirements, there's an AAF Filter of a type and capacity to meet your needs. Write for complete catalog data on the Electro-Cell and other AAF electronic filters.

AMERICAN AIR FILTER COMPANY, INC.

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AAF

AIR FILTERS

AND DUST CONTROL EQUIPMENT

this cable won't quit when jobs are HOT!

Wiring in high-temperature locations is vital to steady plant operation. If a power cable quits, if a control circuit fails, it may ruin a "heat" or close down a department.

For years, plant engineers with hot jobs to wire have specified Deltabeston* power cable and boiler-room wire. They recognize the practical application experience which General Electric has been able to put behind them. They know that new research is always under way.

In many cases, too, it's the selection of the right *type* of heat-resistant cable that's so important to long life. The Deltabeston line includes standards and "specials" for every combination of heat, moisture, corrosive vapor or other condition. And *men who know the problem* stand back of your Deltabeston supply source, ready to advise you or your contractor on selection. For full information on Deltabeston cables or wires for *any* hot job, write Section Y53-146, Appliance and Merchandise Department, General Electric Company, Bridgeport 2, Connecticut.

**Trade-mark Reg. U. S. Pat. Off.*

GENERAL ELECTRIC

HI-AMBIENTS

Practical product suggestions from your Deltabeston Distributor

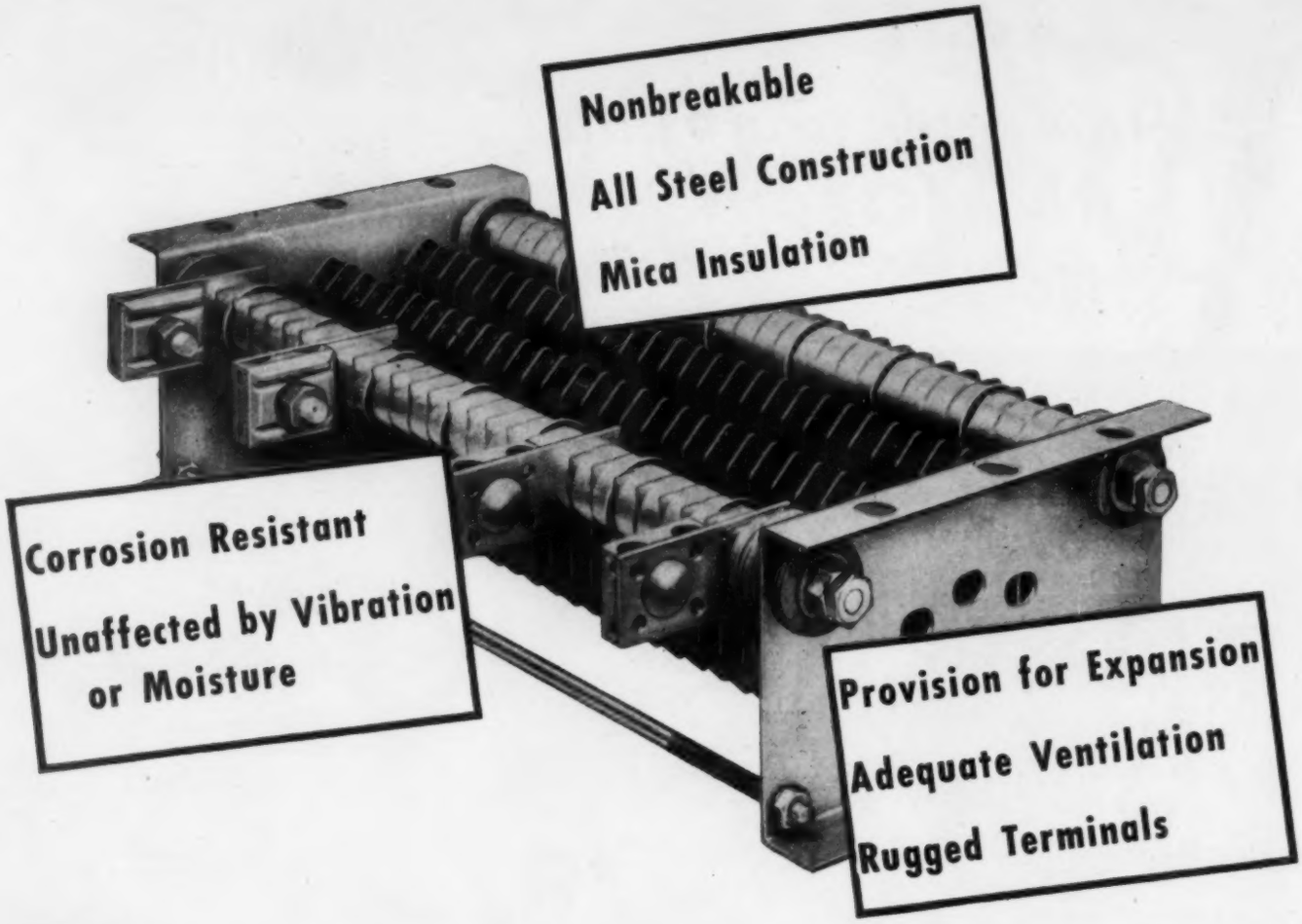
FOR FLEXIBLE LEADS . . . on heavy apparatus that involves hot work, such as electric furnaces, cranes handling hot metals, and the like, Deltabeston YK-2253 is a popular choice. Insulated with an impregnated wall of felted asbestos and asbestos braid, it resists heat, flame, oil and corrosive vapors up to 125 C (257 F).

IF YOU ARE PUZZLED . . . as to the relative merits of asbestos-insulated versus glass-insulated magnet wire for any particular application, you can get unbiased advice from Deltabeston application specialists. The Deltabeston line includes both. And for extra severe jobs, glass-insulated wire with *silicone varnish* is now becoming available. Its rating is 200 C.

FLUORESCENT FIXTURES . . . need heat-resistant wiring in and around the ballast. For those located in hot, humid places, *all* the wiring should be heat resistant. Why not make your installation with the same type of Deltabeston wire which ballast and fixture manufacturers use?

WIRING JET PLANES . . . may be a long way from your business, but the choice of a Deltabeston Aircraft Wire for this extra-severe duty helps explain why so many folks turn to us for solutions to "impossible" insulation requirements.

DELTABESTON
Wires and Cables
Built to beat the heat



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Write for Bulletin No. 500

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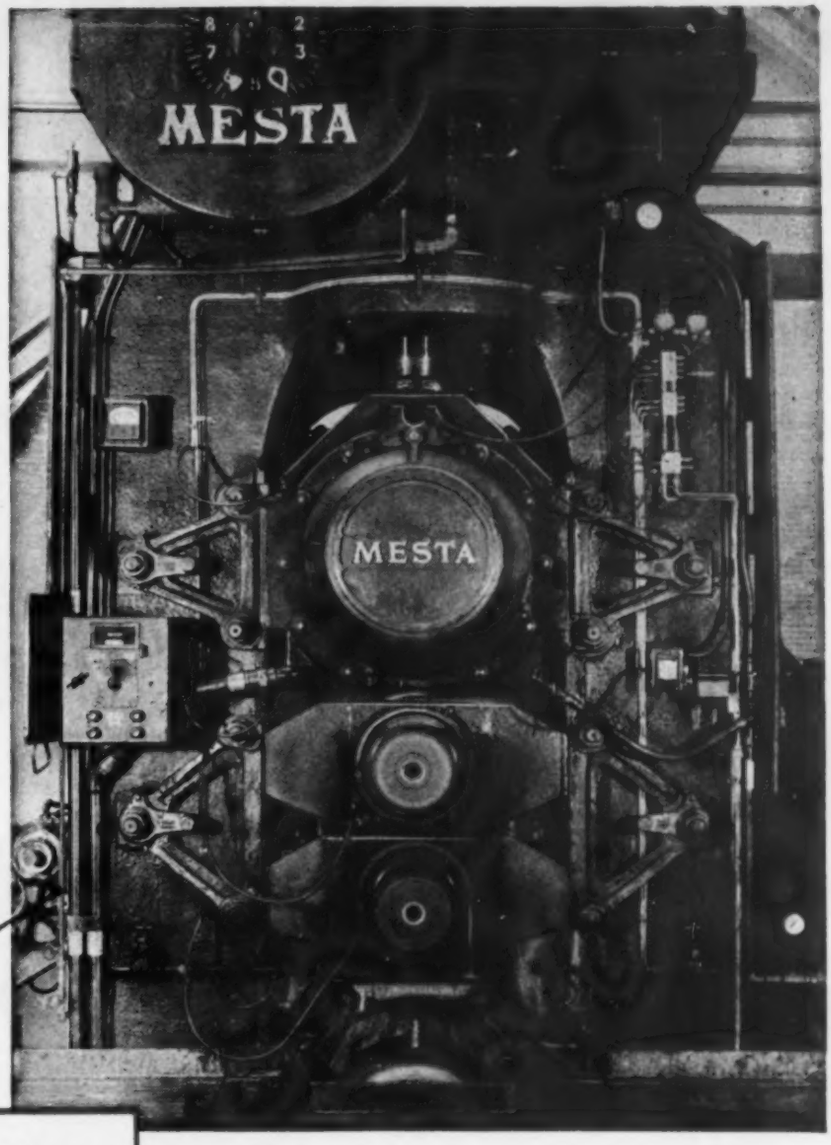

Keep your lubricating systems clean...Use *Texaco Regal Oils.*

Texaco Regal Oils are turbine grade, heavy duty circulating oils . . . especially made to resist oxidation, emulsification and sludge formation. Thus, they keep the circulating system clean . . . reduce maintenance costs. In addition, they stand up under high speeds and temperatures, and carry heavy loads easily.

For your heavy-duty enclosed gears (pinion and worm), use *Texaco Meropa Lubricants.* They have ample capacity to carry any possible shock loads or pressures. They prevent bearing corrosion . . . assure longer gear and bearing life.

Let a Texaco Lubrication Engineer work with you to keep your production rolling. Just call the nearest of the more than 2500 Texaco Distributing Plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, New York.

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TEXACO Regal Oils
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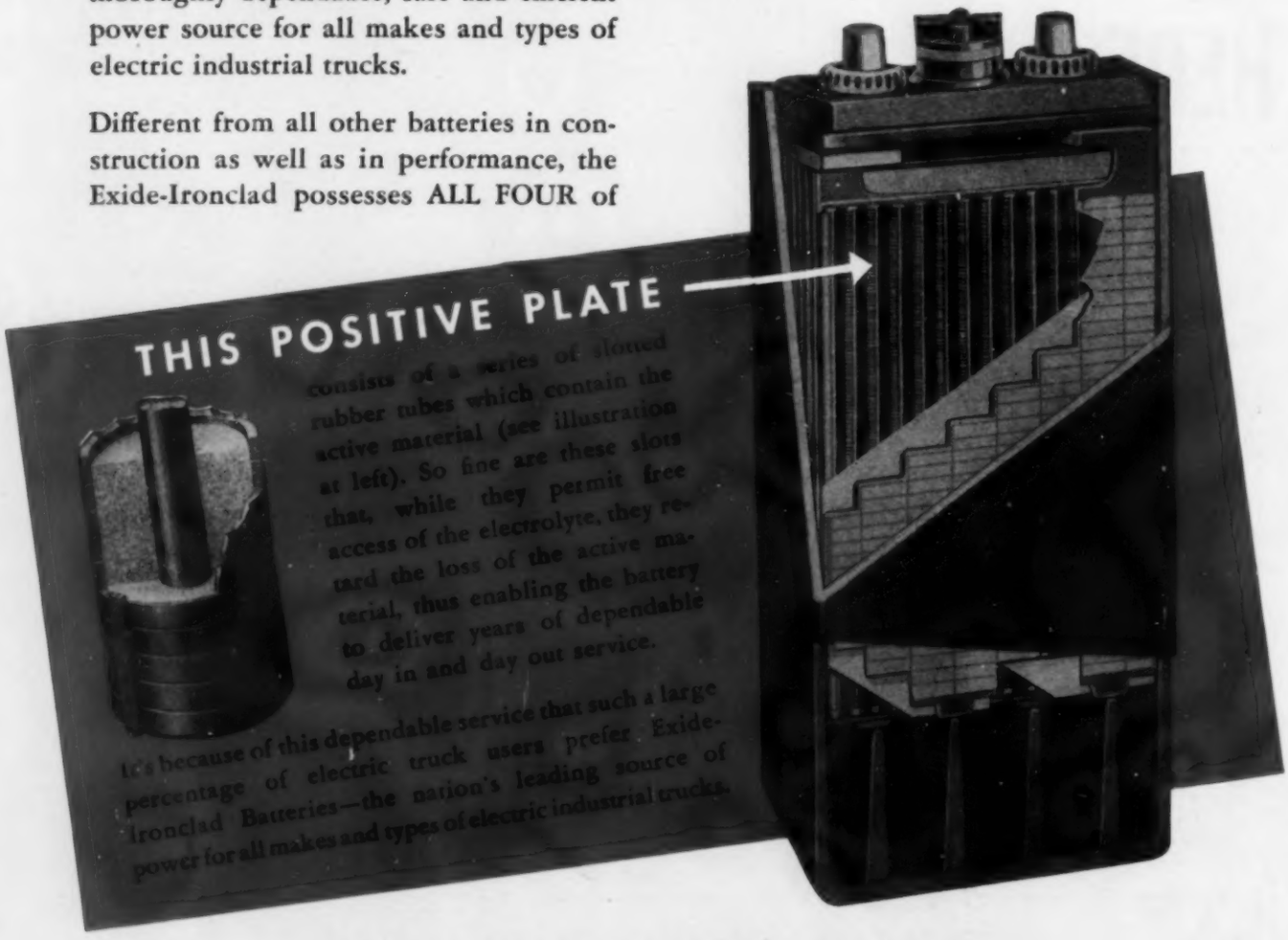
USERS EXPRESS PREFERENCE FOR Exide IRONCLAD BATTERIES

IN a recent national survey made by a leading industrial publication, 81.1% of electric industrial truck users expressed a preference for Exide-Ironclad Batteries.

Such overwhelming preference for the Exide-Ironclad Battery is based upon user experience. This unique battery has, during the past 35 years, proved itself to be a thoroughly dependable, safe and efficient power source for all makes and types of electric industrial trucks.

Different from all other batteries in construction as well as in performance, the Exide-Ironclad possesses ALL FOUR of the essential characteristics demanded of a battery for electric industrial truck service—(1) high power ability, (2) high efficiency, (3) great ruggedness, and (4) long life. These characteristics are due to the special construction of the Exide-Ironclad Battery, especially its rugged, tubular positive plate.


THIS POSITIVE PLATE
consists of a series of slotted rubber tubes which contain the active material (see illustration at left). So fine are these slots that, while they permit free access of the electrolyte, they retard the loss of the active material, thus enabling the battery to deliver years of dependable day in and day out service.
It's because of this dependable service that such a large percentage of electric truck users prefer Exide-Ironclad Batteries—the nation's leading source of power for all makes and types of electric industrial trucks.

Write for further particulars and FREE copy of Exide-Ironclad Topics, which covers latest developments in material handling and shows actual case histories.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia 32 • Exide Batteries of Canada, Limited, Toronto

For faster, better piping jobs get everything from CRANE

An all-Crane installation! That's a sure way to keep piping jobs moving swiftly and smoothly—from design to erection to maintenance. Crane quality throughout—in valves, fittings, pipe, accessories, and fabricated piping—makes dependable performance a foregone conclusion.

ONE SOURCE OF SUPPLY
RESPONSIBILITY
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Look at this steam header installation for example. Every piping item is from Crane. That means all the benefits of standardization . . . all the benefits of this 3-way advantage:

ONE SOURCE OF SUPPLY offering the world's most complete selection of steel, iron, brass and alloy piping materials for all power, process, and general service applications.

ONE RESPONSIBILITY for piping materials—helping you to get the best installation and to avoid needless delays on jobs.

OUTSTANDING QUALITY in every item—assuring uniform dependability and durability in every part of piping systems.

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
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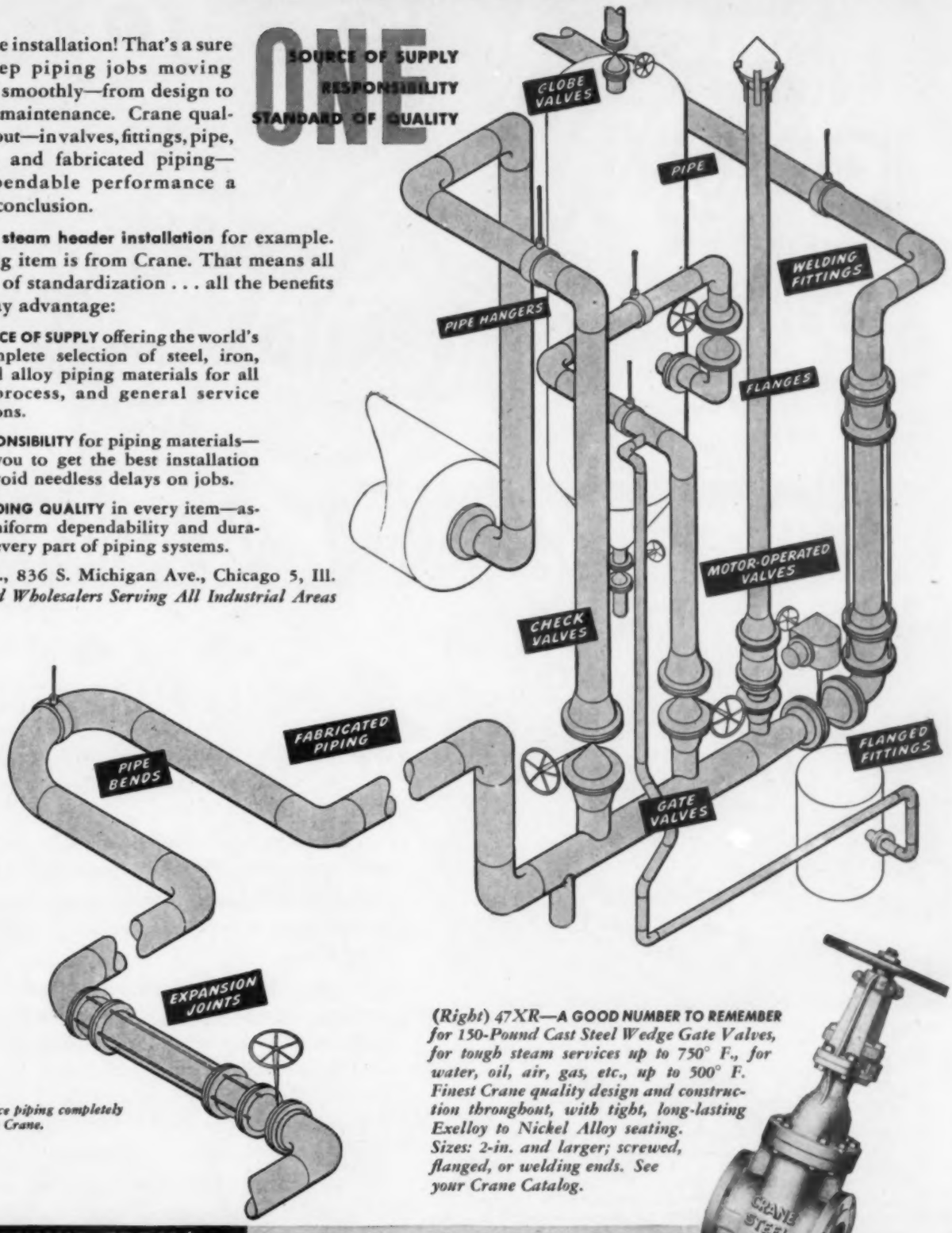

Steam service piping completely equipped by Crane.

(Right) 47XR—A GOOD NUMBER TO REMEMBER for 150-Pound Cast Steel Wedge Gate Valves, for tough steam services up to 750° F., for water, oil, air, gas, etc., up to 500° F. Finest Crane quality design and construction throughout, with tight, long-lasting Exelloy to Nickel Alloy seating. Sizes: 2-in. and larger; screwed, flanged, or welding ends. See your Crane Catalog.

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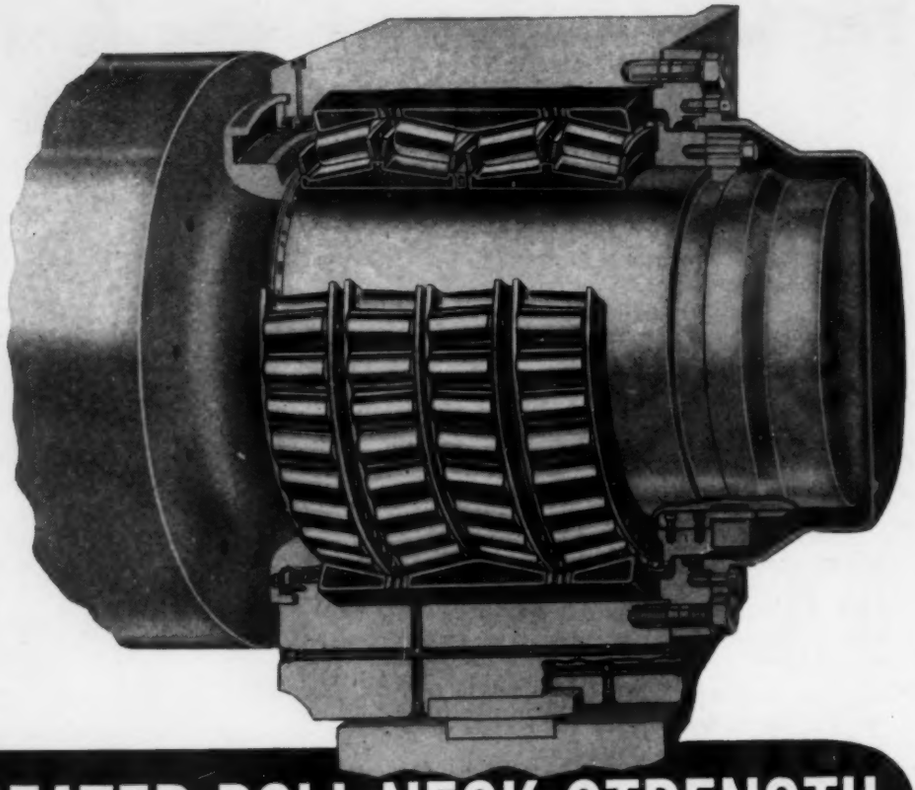
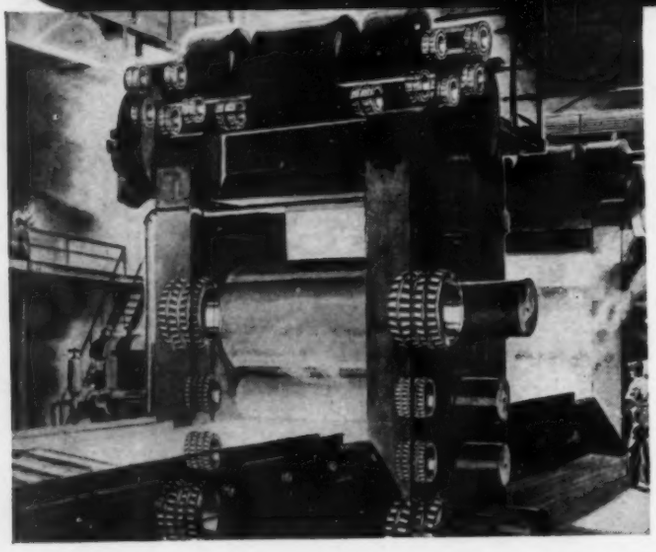
CRANE

FOR EVERY PIPING SYSTEM

Timken balanced proportion Roll neck bearings assure...



50%-60% GREATER ROLL NECK STRENGTH



...with the help of NICKEL ALLOY STEEL

The cut-away view shows you a rolling mill bearing that provides peak performance plus long term endurance.

In addition to making possible larger, stronger mill roll necks, Timken Balanced Proportion Bearings show load ratings ranging up to 40% higher than in previous designs of tapered roller bearings.

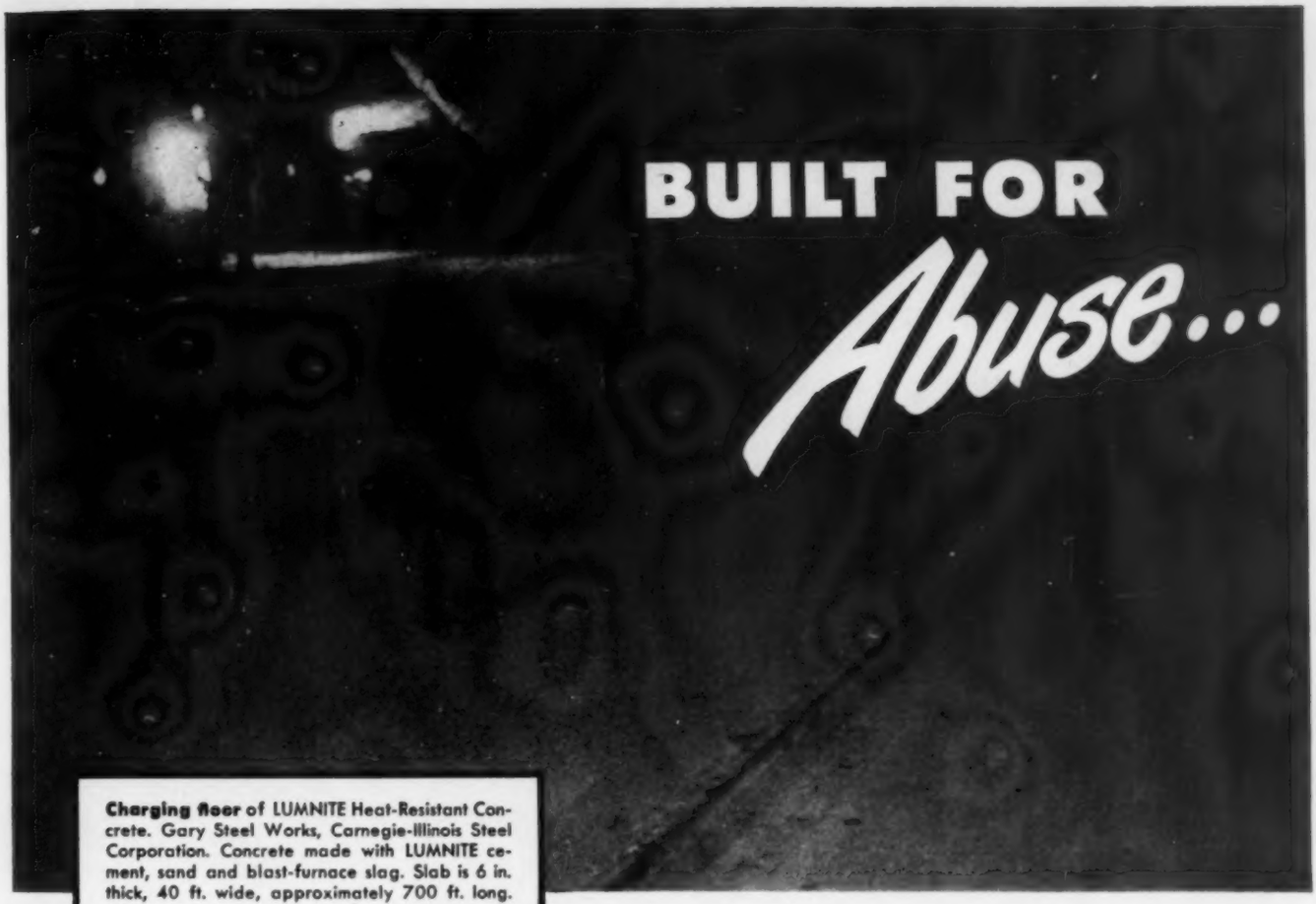
Produced from a modified Type 3312 Nickel-chromium steel, Timken Roll Neck Bearings not only reduce starting and operating friction, but also withstand heavy shock loads because the Nickel alloy steel rollers and races have a high degree of hardness in the case, together with an exceptionally tough, strong core.

Experience proves that it pays to use Nickel alloyed steels for heavy-duty service. Nickel and its alloys may help to improve your products or equipment. Send us details of your problems for our recommendations. Write today.

EMBLEM OF INCO SERVICE TRADE MARK

Over the years, International Nickel has accumulated a fund of useful information on the selection, fabrication, treatment and performance of engineering alloy steels, stainless steels, cast irons, copper-base and other alloys containing Nickel. This information is yours for the asking. Write for "List A" of available publications.

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N.Y.



Charging floor of LUMNITE Heat-Resistant Concrete. Gary Steel Works, Carnegie-Illinois Steel Corporation. Concrete made with LUMNITE cement, sand and blast-furnace slag. Slab is 6 in. thick, 40 ft. wide, approximately 700 ft. long.

Open-hearth charging floor of LUMNITE concrete resists...

Scraping and Dragging • Metal Spillage
Continuous Heat • Banging and Vibration

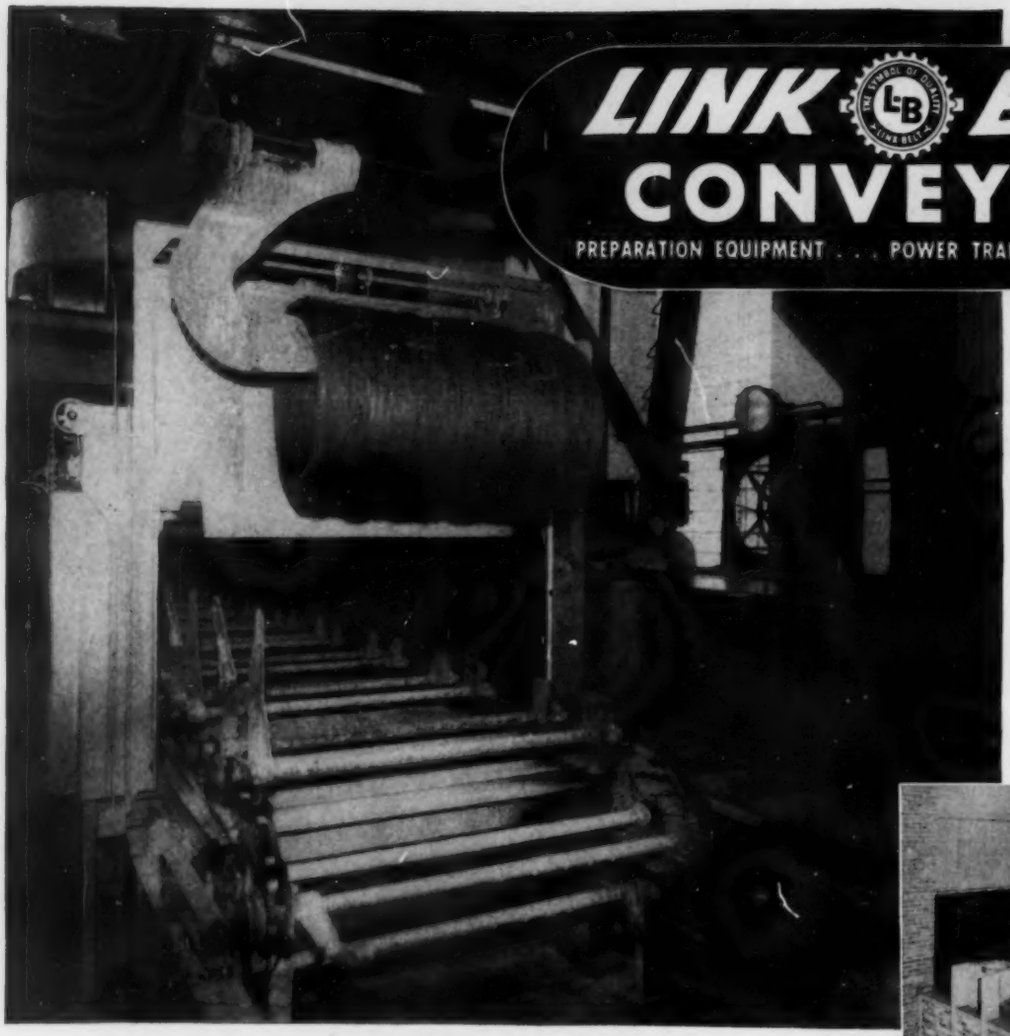
A smooth, level, jointless floor makes it easy to shovel materials and handle tools. A concrete floor is ideal, provided it withstands heat from the furnaces, shaking by the charging machine, occasional spattering of metal—plus the constant wear and tear from charging boxes, ladles and scrap.

Heat-Resistant concrete made with LUMNITE cement meets these requirements. Heat, vibration and shock do not break down the concrete. The easy-to-sweep surface encourages good housekeeping. Safety, too, is increased by getting rid of ragged, foot-tripping pavements.

Old floors can be quickly replaced because rapid-hardening LUMNITE concrete is ready for service in 24 hours. Write for booklets giving full information on aggregates, mixes and methods of placing Heat-Resistant Concrete and Refractory Concrete.

Lumnite Division
UNIVERSAL ATLAS CEMENT COMPANY
UNITED STATES STEEL CORPORATION SUBSIDIARY
135 EAST 42nd STREET • NEW YORK 17, N. Y.

"THE THEATRE GUILD ON THE AIR"—*Sponsored by U.S. Steel—Sunday Evenings—ABC Network*

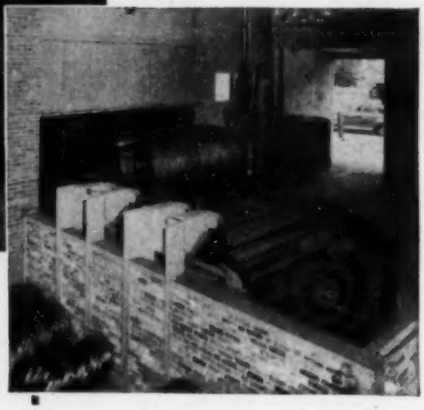


LINK-BELT CONVEYORS

PREPARATION EQUIPMENT . . . POWER TRANSMISSION MACHINERY

◀ Loading 3000 lb. coil of rod on Link-Belt conveyor entering 100 foot long Ross rod baker.

Loading 3000 lb. coil of steel rod on Link-Belt conveyor entering storage room of new cleaning house. ▼



EFFECT HUGE INCREASE in WIRE PRODUCTION

Modernization of handling methods at the Gilbert & Bennett wire mill, Georgetown, Conn., has speeded production to 250% of former rates; provided accurate control of operations; reduced wire drawing die costs, and has greatly improved working conditions.

Two Link-Belt conveyors, moving 3000 lb. coils of rod through storage room and baking oven are important factors in the overall efficiency of the newly-built cleaning house. Coils are stored off the floor at all times. Push button controls centralize all handling operations.

Mill equipment by Link-Belt means a complete Link-Belt service — design, manufacturing, installation. As a pioneer in the development of materials handling in the steel industry, Link-Belt is preeminently fitted to aid you in practical, proven, cost-reducing mechanization.

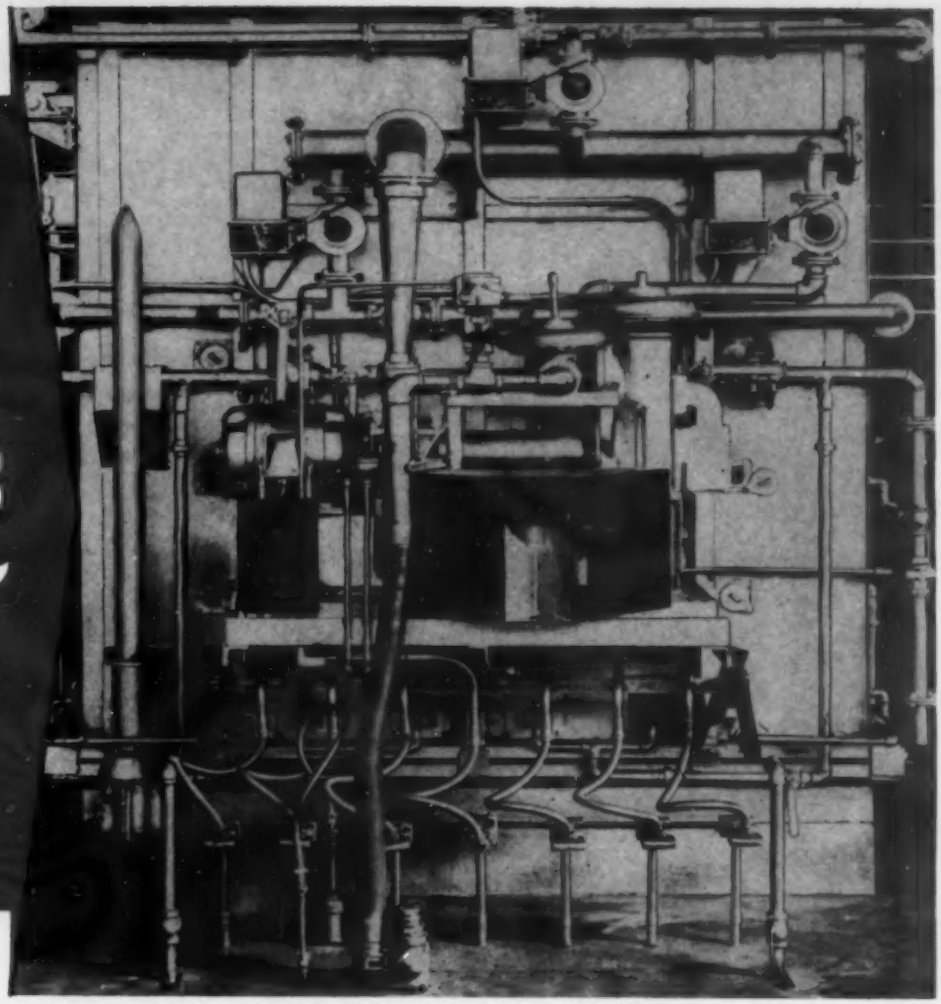
LINK-BELT COMPANY 10,952

Chicago 9, Pittsburgh 19, Cleveland 13, Detroit 4, Indianapolis 6, St. Louis 1, Kansas City 6, Mo., Philadelphia 40, Atlanta, Dallas 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8. Offices in Principal Cities.

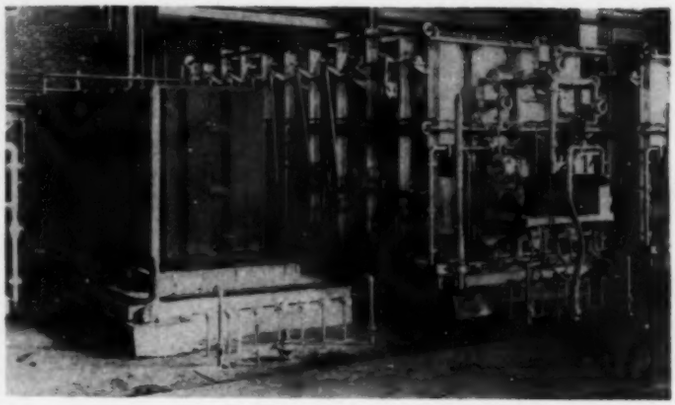
SERVICE TO STEEL BY LINK-BELT..

Complete line of Chains for transfer tables, coil conveyors, furnace conveyors, feeder and catcher tables, sheet pilers, draw bench and other equipment . . . Elevators and Conveyors of all types, such as belt, bucket, screw, flight, Bulk-Flo, drag chain, apron, Sidekar-Karrier, trolley, Oscillating, etc. . . . Feeders . . . Vibrating Screens . . . Dryers and Coolers . . . Skip Hoists . . . Car Dumpers . . . Car Spotters and Haulage Systems . . . Portable Conveyors and Bucket Loaders . . . Traveling Water-Intake Screens . . . Automatic Stokers . . . Silent and Roller Chain Drives . . . Speed Reducers and Increasers . . . Variable Speed Transmissions . . . Electrofluid Drives . . . Sprockets . . . Gears . . . Clutches . . . Couplings . . . Babbitted, Ball and Roller Bearings, etc.

HERE'S THE ANNEALING FURNACE THAT MAKES HEAT BEHAVE!



The end of the Salem endothermic atmosphere annealing hood furnace where control and fuel connections are made to each base.



One of an 8 unit battery used in large-capacity production on long-cycle anneals, to give good structure and best possible surface of work . . . tubing, bars, coils, and strip.

ARE YOU ready for work? . . . this Salem batch-type, special atmosphere annealing furnace will hustle the heat to annealing temperature in record time to eliminate costly delay. Then, exceedingly accurate controls step in to handle the load through criticals and cooling stages.

ARE YOU fussy about your approach, your criticals, soaks, cooling? . . . do you have your own pet curves for the ideal annealing cycle? . . . this furnace will adjust to your methods.

DO YOU believe that the heat source should be as direct to the work as possible for efficiency and economy. (Direct Firing, we call it) . . . in this furnace burners are placed around the perimeter and bathe the entire charge in a uniformly radiant and evenly distributed heat. SALEM features a special heat gradient check. Tops of charges won't overshoot.

DO YOU require extreme accuracy of control? Are you insistent upon cleanliness, economy of operation and maintenance, and endurance? The Salem batch-type annealing furnace has all of these characteristics *proved* by six years of actual use and *approved* by a wide variety of users.

Write FOR FULL INFORMATION TODAY

F-7

Salem Engineering Company

HEADQUARTERS FOR HEAT TREATING DESIGN

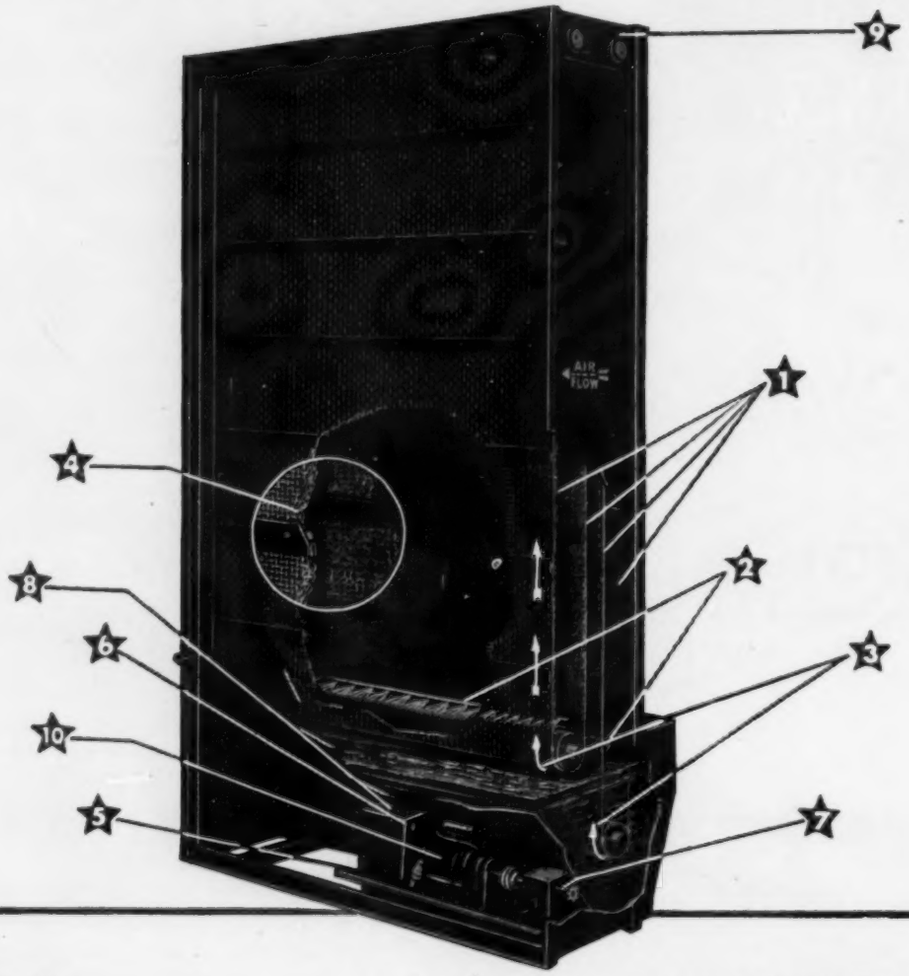
Salem, Ohio *Southwest Office, Fort Worth, Texas*

SALEM ENGINEERING (CANADA) LTD., TORONTO, ONT.
SALEM ENGINEERING COMPANY, LTD., SHEFFIELD, ENGLAND

STAYNEW AUTOMATIC

No other Air Filter can give you these

10 IMPORTANT FEATURES



1. Double Filter Curtains.
2. Compressed Air "Conditioning" of Filter Curtains —absolutely no oil entrainment.
3. Direction of Curtain Travel such that *cleaned* panels are *always* on downstream or filtered air side.
4. Highest Efficiency of any mechanical type self-cleaning filter plus exceptionally large dust-handling ability.
5. Motor and Control Unit mounted on *clean* air side of filter.
6. Momentary Contact Time Switch for testing and checking curtain travel and compressed air control.
7. Shear Pin Protection of moving parts from accidental damage.
8. Control Mechanism arranged as an integral part of filter unit or for remote mounting.
9. Gear and Roller Chain Drive. *No belts to slip.*
10. Nation-wide Service on both motor and controls.

DOLLINGER CORPORATION

16 CENTRE PARK ROCHESTER 3, N. Y.

DOLLINGER PROTECTO MOTOR STAYNEW FILTERS

UNITED 16" & 49" x 68"—4-High Sheet Mill

UNITED SHEET MILLS

UNITED mills of the type illustrated are widely used in the cold reduction of both ferrous and non-ferrous metals.

We are now building two similar mills for rolling stainless steel.

Designs of these new units are available for duplication; or they may be modified to suit your requirements.

Why not ask our engineers for further particulars.

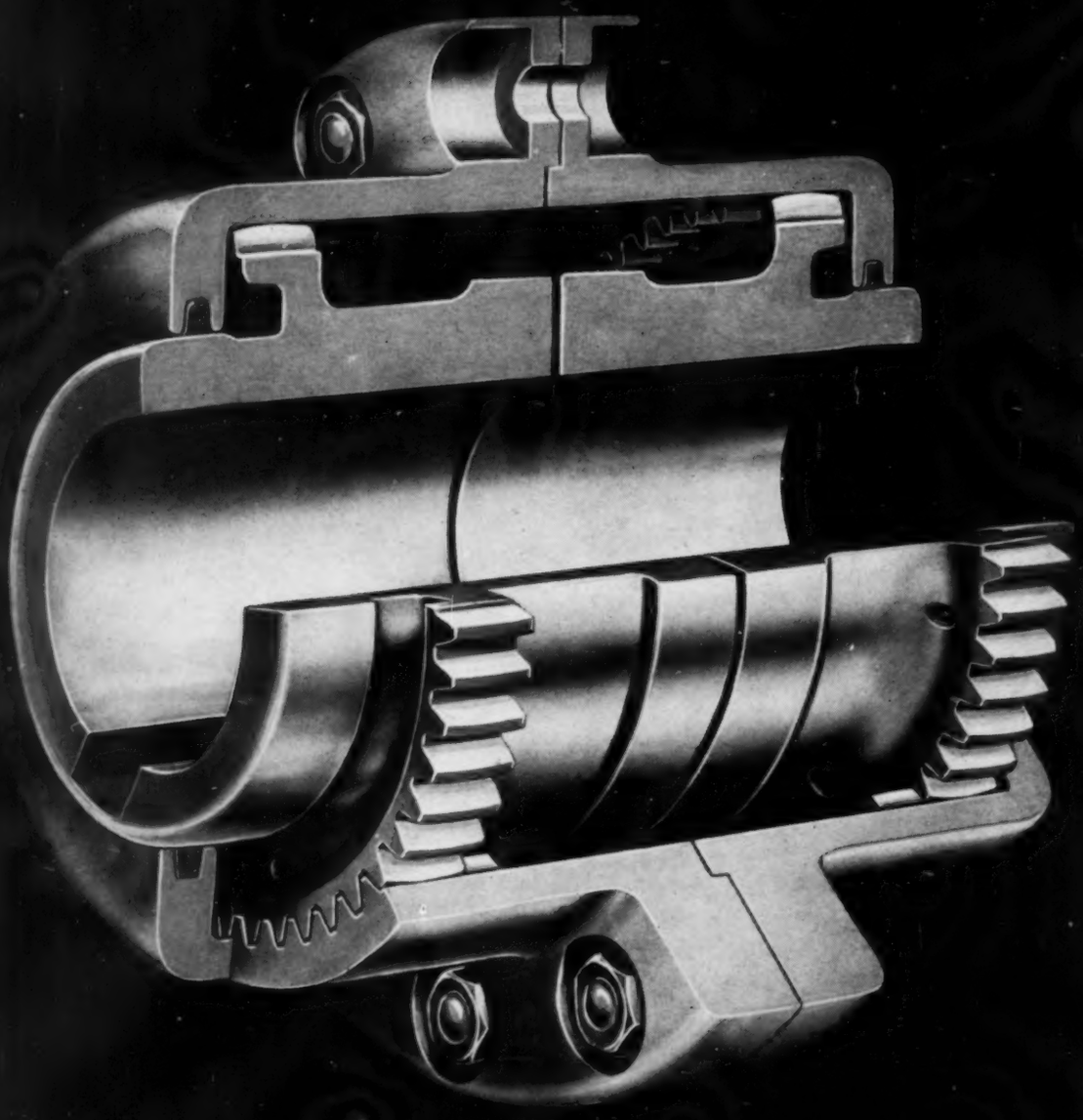
UNITED ENGINEERING AND FOUNDRY COMPANY

PITTSBURGH, PENNSYLVANIA

Plants at Pittsburgh, Vandergrift, New Castle, Youngstown, Canton
Subsidiary: Adamson United Company, Akron, Ohio
Affiliates: Davy and United Engineering Company, Ltd., Sheffield, England
Dominion Engineering Works, Ltd., Montreal, P. Q. Canada
S. E. C. I. M., Paris, France

DESIGNERS AND MAKERS OF ROLLS AND ROLLING MILL EQUIPMENT

POOLE



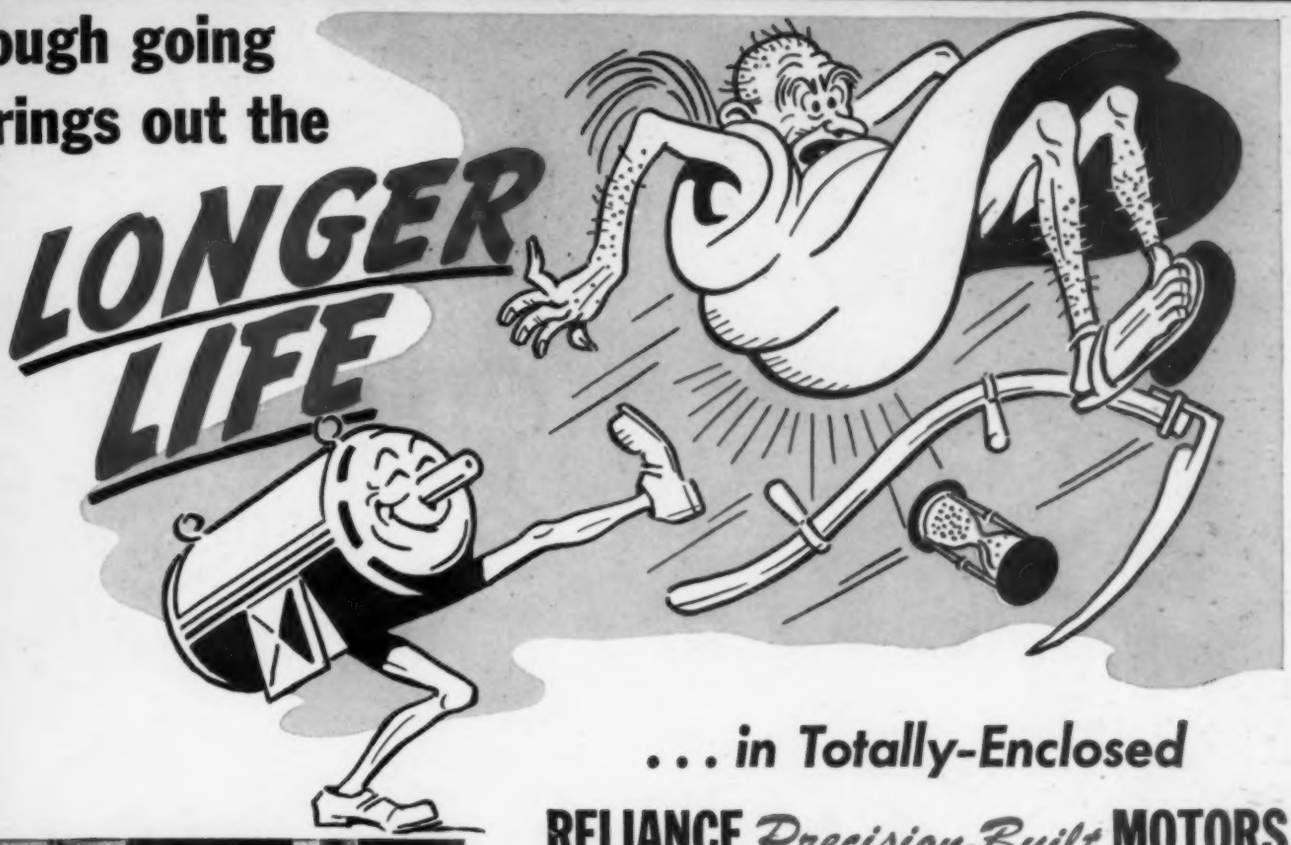
A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.

Tough going brings out the LONGER LIFE



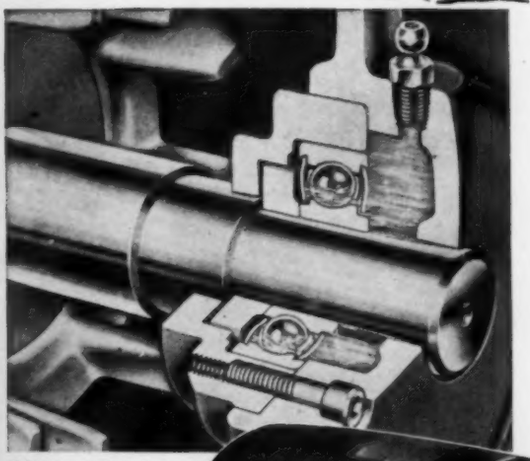
. . . in Totally-Enclosed

RELIANCE *Precision-Built* MOTORS

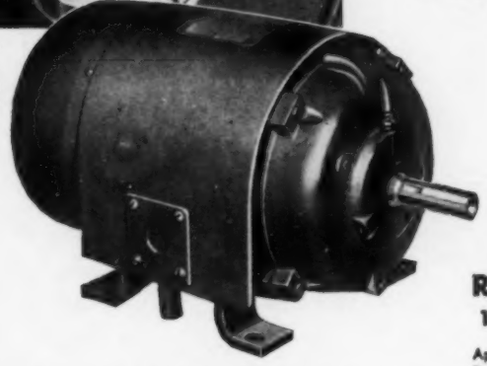
Wherever motors operate frequently under abnormal conditions, Totally-Enclosed, Fan-Cooled Reliance A-c. Motors continually amaze users by their longer life. That important extra protection they have—against moisture in the air, against liquids splashed or streamed right on them, against dust and abrasives—pays so much more than it costs!

There's *extra* protection inside, too—to make that longer life of dependable service doubly sure. Ventilation that licks the heat problem is provided by air drawn through end bracket and directed by baffles through streamlined passages.

Thirteen-point winding treatment includes six special steps to assure the most effective insulation possible. And an improved bearing design eliminates all lubrication worries! Write today for Bulletin C-125 (Bulletin C-218 if interested in D-c. motors).



This special bearing design protects Reliance Precision-Built Motors indefinitely!



Reliance Totally-Enclosed, Fan-Cooled, Precision-Built Motor. *For convenience, conduit box of Reliance Motors may be mounted in any of four positions or completely eliminated, as shown here.*

RELIANCE ELECTRIC & ENGINEERING CO.
1084 IVANHOE ROAD • CLEVELAND 10, OHIO

Appleton, Wis. • Birmingham • Boston • Buffalo • Chicago • Cincinnati • Dallas
Denver • Detroit • Gary • Grand Rapids • Greenville, S. C. • Houston • Kansas City
Knoxville • Little Rock • Los Angeles • Milwaukee • Minneapolis • New Orleans
New York • Philadelphia • Pittsburgh • Portland, Ore. • Roanoke, Va. • Rockford
St. Louis • San Francisco • Seattle • Syracuse • Tampa • Tulsa • Washington, D.C.
Sao Paulo, Brazil

RELIANCE A-C D-C MOTORS

"Motor-Drive is More Than Power"

Continuous Pickling Lines

built by MESTA

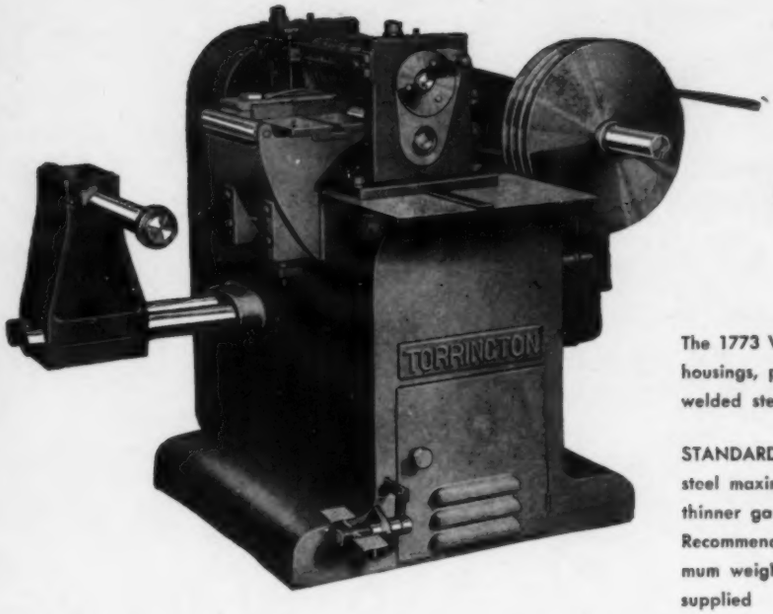
A Mesta Continuous Pickling Line delivers greater tonnage of strip steel. This is due not only to the design and sturdiness of the individual units, but also to correct engineering of the entire process.

The Mesta-Thomson Flash Welder, located at the entry end of continuous pickling lines, produces heavier coils with butt welded joints suitable for cold rolling on high speed mills.

DESIGNERS AND BUILDERS OF COMPLETE STEEL PLANTS

MESTA MACHINE COMPANY · PITTSBURGH, PA.

A *NEW* WAREHOUSE SLITTER



The TORRINGTON WAREHOUSE METAL SLITTING MACHINE 1773*

IN the field of warehouse metal slitting, a compact, smoothly running, well-guarded slitter is required, which above all may be quickly set up to produce any desired combination of cuts on any gauge of metal within its range.

The Torrington *1773 Warehouse Type Metal Slitting Machine has been especially designed to meet these requirements. Years of experience in building metal slitting machines have been applied to the development of this model, which was first announced at the recent National Metal Exposition. The enthusiastic reception of the 1773 has proved the desirability of the design, and enabled Torrington to commence manufacturing in production lots, which makes possible a highly competitive price.

Detailed specifications and quotation will be furnished upon request.

The 1773 Warehouse Type Metal Slitting Machine is a compact unit. The housings, payoff, winder and motor drive are all mounted on a single welded steel base, reducing floor space to approximately 4' x 6'.

STANDARD CAPACITY—5 cuts (4 strips) .080" non-ferrous or .062" mild steel maximum thickness, or an equivalent number of additional cuts in thinner gauges up to 12" or 18" maximum trimmed width respectively. Recommended minimum thickness .010". Maximum O.D. of coil 20"; maximum weight of coil, 400 lbs. Special supports for heavier coils can be supplied

SPEED—150 F. P. M.

CUTTERS AND CUTTER ARBORS—Cutters (separately quoted) are 5½" diameter, of either alloy tool steel or hi-carbon, hi-chrome steel. Arbors are of steel, 2⅝" diameter, with ½" x ½" key.

ADJUSTMENTS—An exclusive feature is a manual adjustment of the top arbor to compensate for wearing down of the cutters. Simple, manually operated spur gears rotate the eccentric arbor bushing at each housing, providing a total adjustment of 9/16".

GUIDE TABLE—At entry has adjustable side guides, wood wipers with spring to exert tension on the metal, and idle guide roller. 40" metal line.

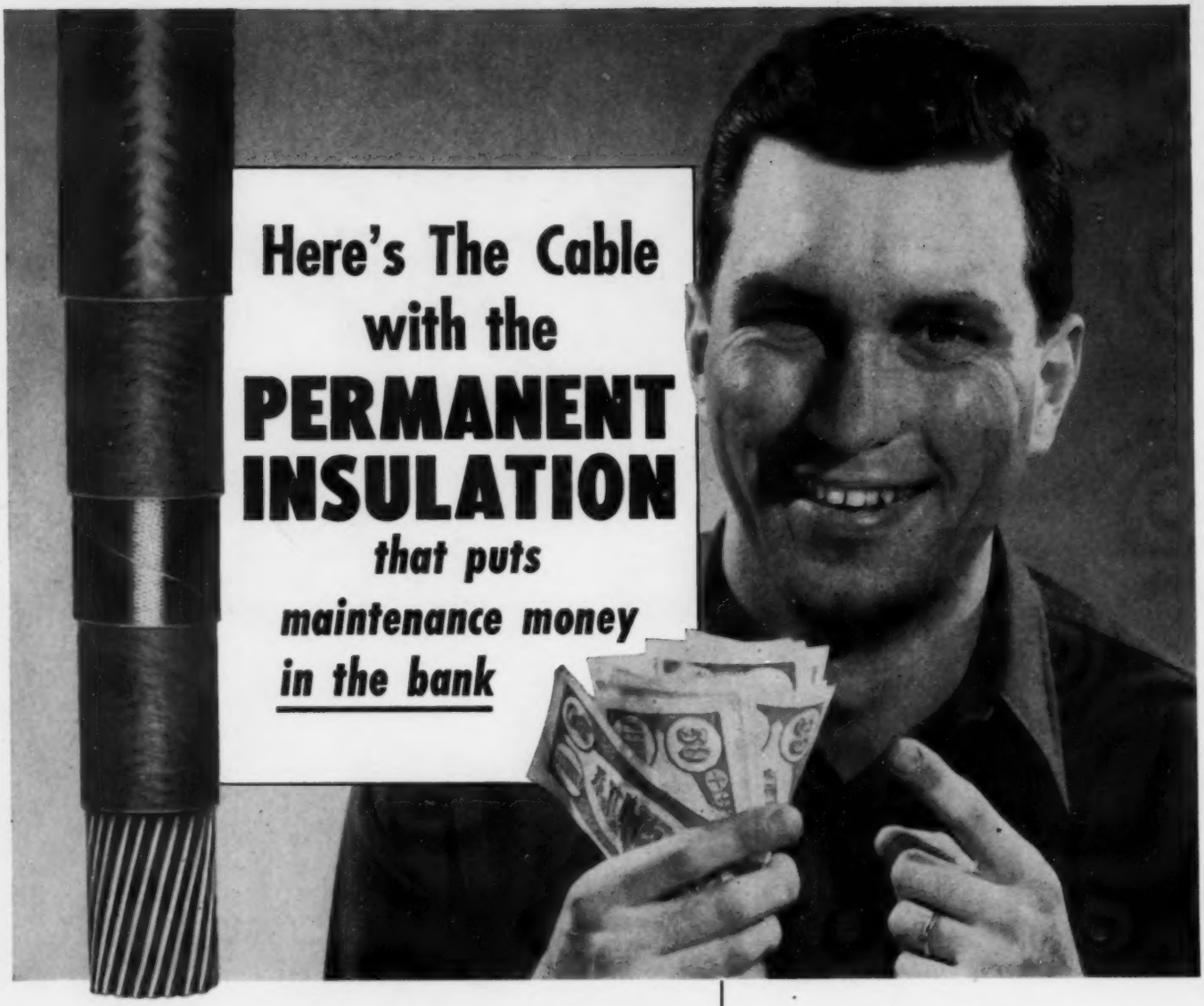
WINDER—At exit consists of a 2½" diameter winding arbor fitted with 3/32" slot and handwheel for starting strips. Recommended maximum thickness on 2½" diameter arbor is .062".

SEPARATOR DISCS—(separately quoted) Hardened and tempered spring steel .055"—.050" thick and 14" or 20" diameter.

DRIVE—Standard make motor, 5 H.P., 1800 R.P.M. Drive to winder through Link leather belt.

*The number "1773" indicates that this is the one thousand seven hundred and seventy-third complete and original design planned on the drafting boards of the Torrington Manufacturing Company. The number of machines built for the metal mills is many times that figure.

The **TORRINGTON**
MANUFACTURING COMPANY
TORRINGTON, CONNECTICUT



Rockbestos A.V.C. is specified by steel mills, refineries, power companies and manufacturing plants because it won't bake brittle, crack or flow when exposed to operating temperatures up to 230°F. Moreover, this cable is not injured by corrosive fumes, grease or oil because it's insulated with *impregnated asbestos* — which won't rot or bloom. And time-tested installations prove conclusively that Rockbestos A.V.C. withstands severe heating and cooling cycles in conduit where other types require frequent replacement.

Couple these maintenance savings with Rockbestos' greater current carrying capacity and it's easy to see why you'll decide on the cable which helps you avoid wasteful maintenance — and steers those dollars toward the bank!

Several types for power, lighting and control circuits, switchboards and equipment, in 600 to 5,000 volt ratings. Write our nearest district office for information or recommendations.

ROCKBESTOS PRODUCTS CORP., 619 NICOLL ST., NEW HAVEN 4, CONN.

NEW YORK BUFFALO CLEVELAND DETROIT CHICAGO
PITTSBURGH ST. LOUIS LOS ANGELES OAKLAND, CAL.

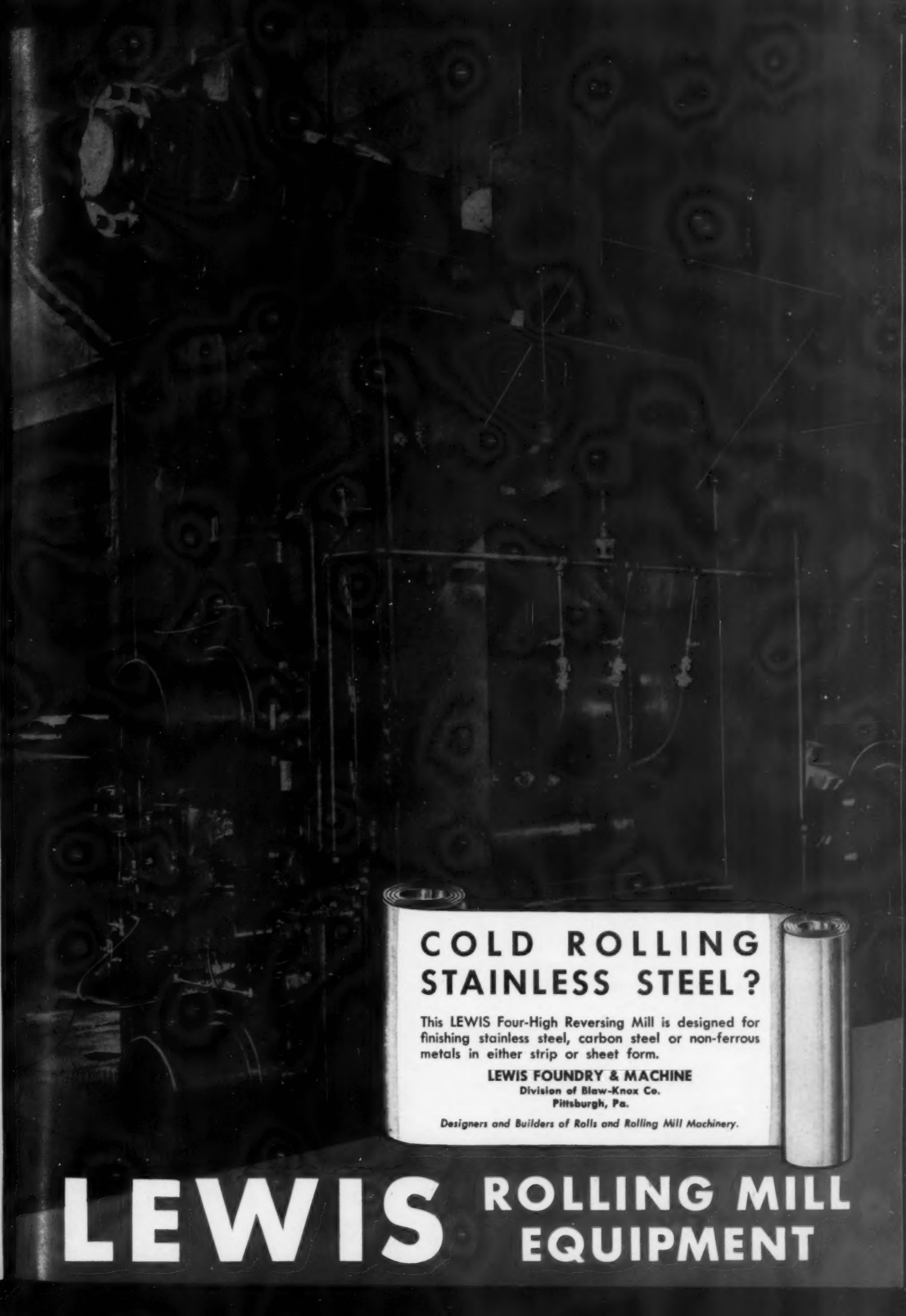
Why It's Trouble-Free!

A tough, non-aging impregnated asbestos braid resistant to heat, flame, moisture, grease, oil and corrosive fumes.

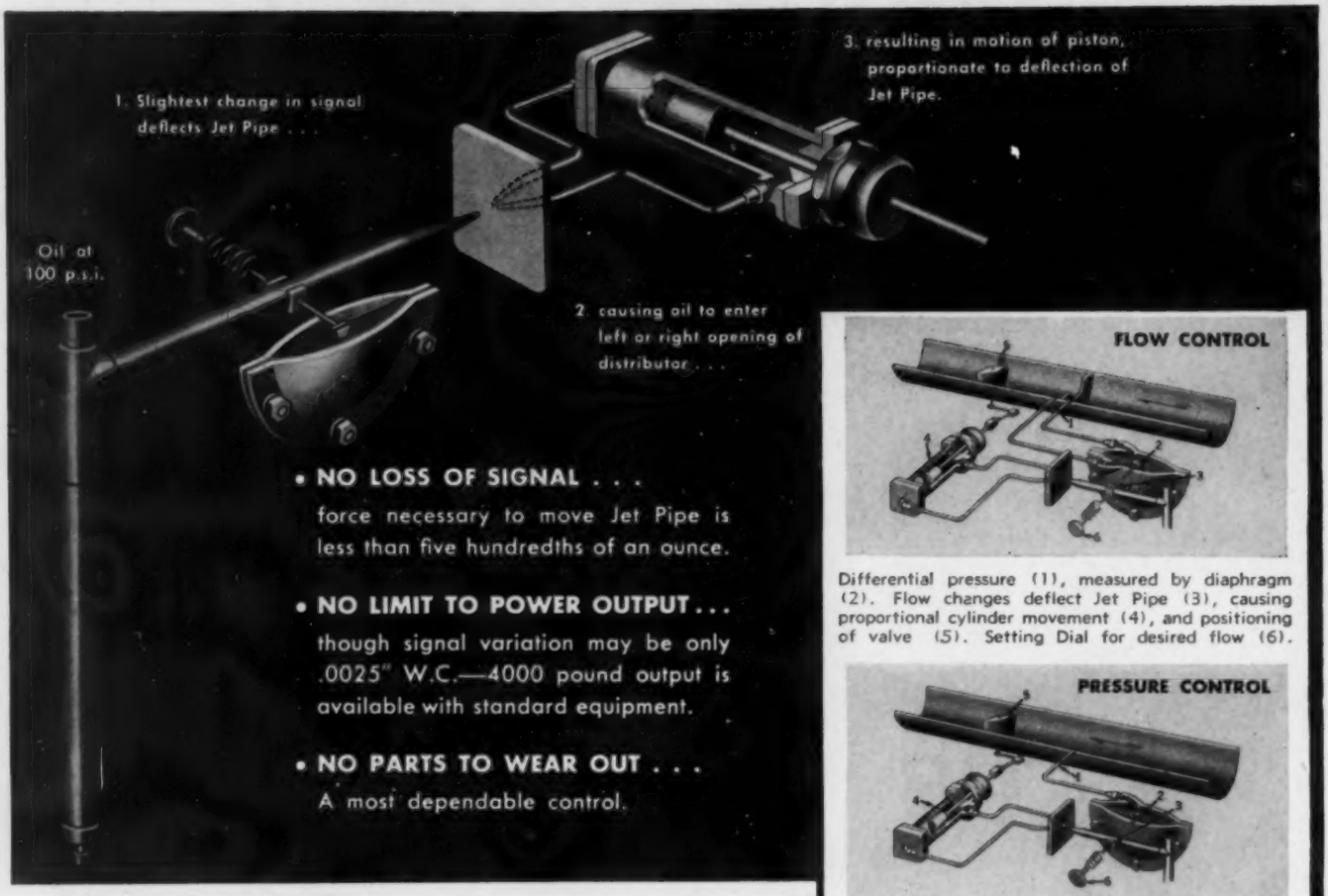
- An outer wall of impregnated felted asbestos that won't dry out, crack, flow, rot or burn — also protects varnished cambric beneath from heat and oxidation.
- Varnished cambric for high dielectric strength and added moisture resistance.
- An inner wall of heat and flame resistant impregnated asbestos which acts as a baffle between the varnished cambric and hot conductors.
- The conductor is perfectly and permanently centered in non-flowing heat resistant insulation that provides greater current carrying capacity.

One of 125 different constructions designed by Rockbestos for severe operating conditions in ratings up to 5000 volts.

ROCKBESTOS A.V.C. ROCKBESTOS *The Wire with Permanent Insulation*


COLD ROLLING
STAINLESS STEEL?
This LEWIS Four-High Reversing Mill is designed for finishing stainless steel, carbon steel or non-ferrous metals in either strip or sheet form.
LEWIS FOUNDRY & MACHINE
Division of Blaw-Knox Co.
Pittsburgh, Pa.
Designers and Builders of Rolls and Rolling Mill Machinery.
LEWIS ROLLING MILL EQUIPMENT

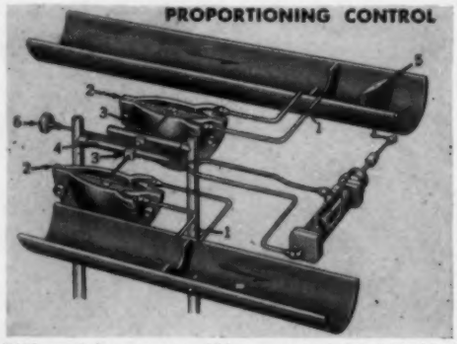
AN EXCLUSIVE CONTROL PRINCIPLE...


1. Slightest change in signal deflects Jet Pipe . . .
3. resulting in motion of piston, proportionate to deflection of Jet Pipe.
Oil at 100 p.s.i.
2. causing oil to enter left or right opening of distributor . . .

- **NO LOSS OF SIGNAL . . .** force necessary to move Jet Pipe is less than five hundredths of an ounce.
- **NO LIMIT TO POWER OUTPUT . . .** though signal variation may be only .0025" W.C.—4000 pound output is available with standard equipment.
- **NO PARTS TO WEAR OUT . . .** A most dependable control.

Differential pressure (1), measured by diaphragm (2). Flow changes deflect Jet Pipe (3), causing proportional cylinder movement (4), and positioning of valve (5). Setting Dial for desired flow (6).

Pressure (1), measured by diaphragm (2). Pressure changes deflect Jet Pipe (3), causing proportional cylinder movement (4), and positioning of valve (5). Setting Dial for desired pressure (6).



Differential pressures (1), measured by individual diaphragms (2). Signal transmitted to opposite sides of Jet Pipe (3). Any unbalance deflects Jet Pipe (4), causing proportional cylinder movement and positioning of valve (5). Setting Dial for ratio (6).

THE ASKANIA JET PIPE PRINCIPLE

The Askania Jet Pipe converts the most delicate pressures or signals from the source of measurement into rate of movement of a hydraulic cylinder. It consists of the Jet Pipe swinging freely on a hollow vertical pivot into which oil is pumped at high pressure. As the oil stream leaves the nozzle of the Jet Pipe it strikes at two closely adjacent distributor openings. The openings are piped to both ends of the cylinder which is connected to valve, damper or other type controller.

The slightest change in the signal moves the Jet Pipe, causing more or less oil to enter the right or left opening. This causes the cylinder to move either to the right or left to correct for the signal variation. As soon as equilibrium is established the Jet Pipe returns to its median position.

For the tough control job . . . for applications where dependability is all important . . . for the processes where accuracy is a necessity . . . and where valves, dampers, or other mechanisms must be moved, the Askania Jet Pipe Controls are the solution. SEND FOR CATALOG 139.

ASKANIA Controls

ASKANIA REGULATOR COMPANY

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

240 EAST ONTARIO STREET • CHICAGO 11, ILLINOIS

1 CARBON BRUSH ELIMINATED 12 SPECIALS!

THERE may be no need for you to stock dozens of made-to-order carbon brushes with slight differences in brush lengths . . . bevels . . . shunt lengths . . . and terminals.

National Carbon Company, Inc., now offers a method of brush standardization that eliminates a great many variables in brush specifications. For example, in one case, standardizing on a single brush eliminated twelve specials. After making a thorough study of the types of equipment in your plant, a small number of "National" carbon brushes can be established to fill your needs.

To save *time* and *money* through *brush standardization,* write or telephone National Carbon Company. Our representative will gladly call at your plant to provide details without cost or obligation.

HOW BRUSH STANDARDIZATION PAYS!

1. Price advantage through quantity discounts
2. Fewer small orders—with savings in bookkeeping, billing, and accounting
3. Less money and space tied up in brush stocks
4. Less time needed to handle stock

The term "National" is a registered trade-mark of

NATIONAL CARBON COMPANY, INC.

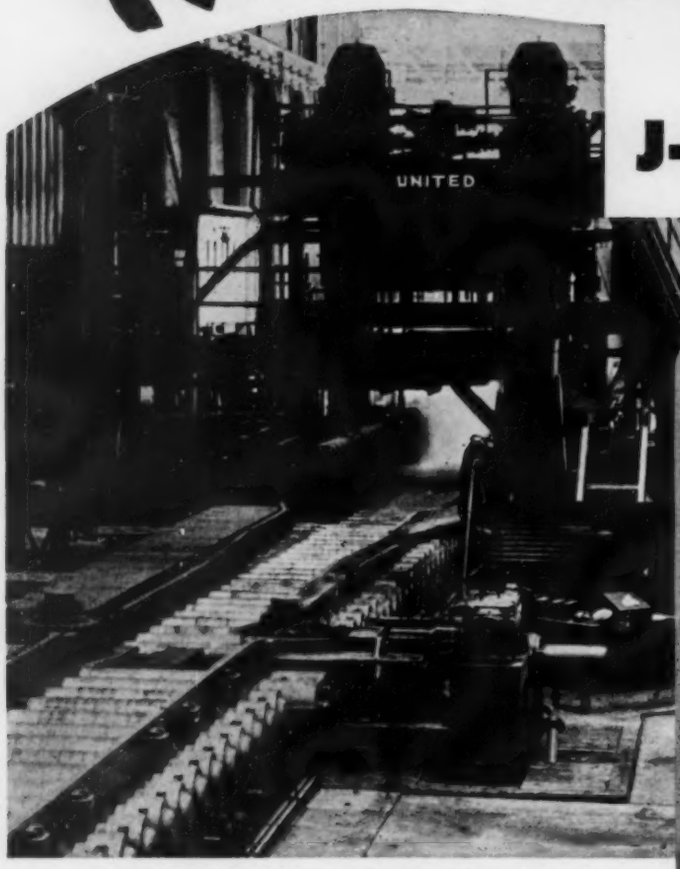
Unit of Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, N.Y.

UCC

Division Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

"Roll Tables" Roll...

equipped with J-M CLIPPER SEALS

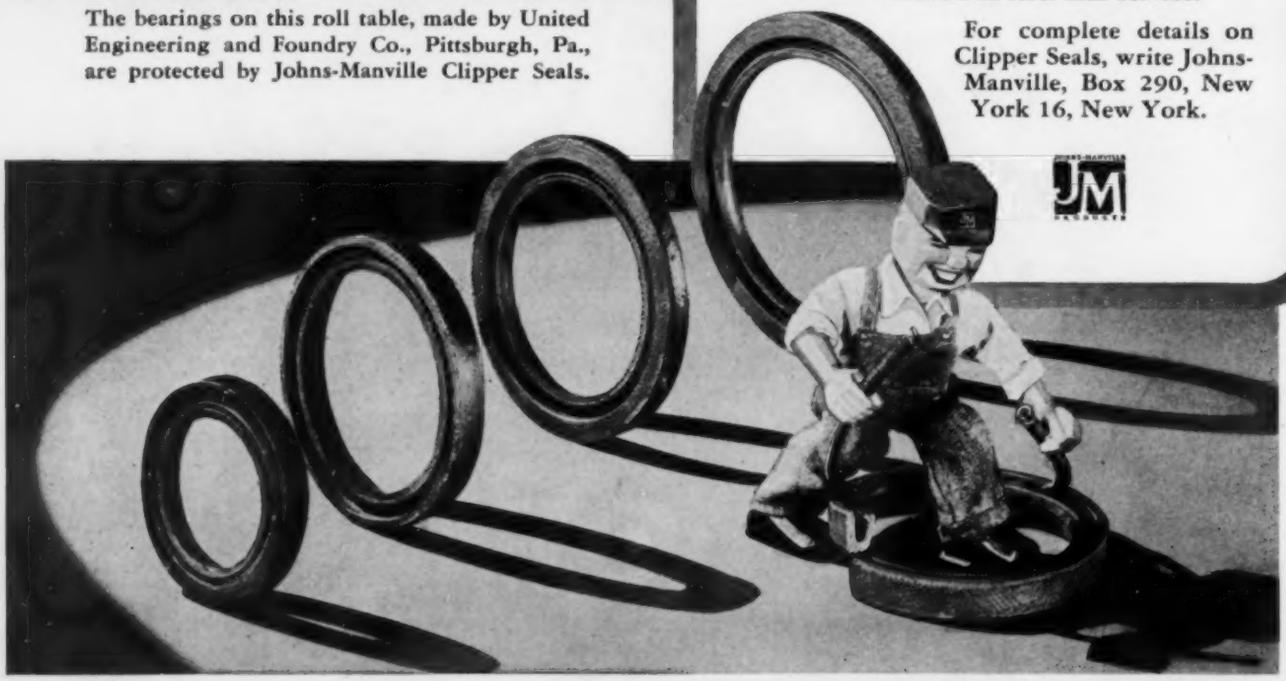


The bearings on this roll table, made by United Engineering and Foundry Co., Pittsburgh, Pa., are protected by Johns-Manville Clipper Seals.

Lubricant stays IN... dirt and water stay OUT when bearings on steel mill equipment are protected with J-M Clipper Seals. That's because their one-piece body is concentrically molded for a precision fit. A flexible "lip," held in light but firm contact by a self-adjusting garter spring, effects a positive seal, at the same time reducing wear on the shaft.

Because Clipper Seals are non-metallic in construction, they are highly resistant to most forms of corrosion. Molded of resin-impregnated fabrics and synthetic rubber compounds, Clipper Seals are tough, long-wearing—successfully meet extreme operating conditions. Performance records confirm their ability to outlast other types of oil seals . . . provide better, more economical bearing protection in steel mill service.

For complete details on Clipper Seals, write Johns-Manville, Box 290, New York 16, New York.



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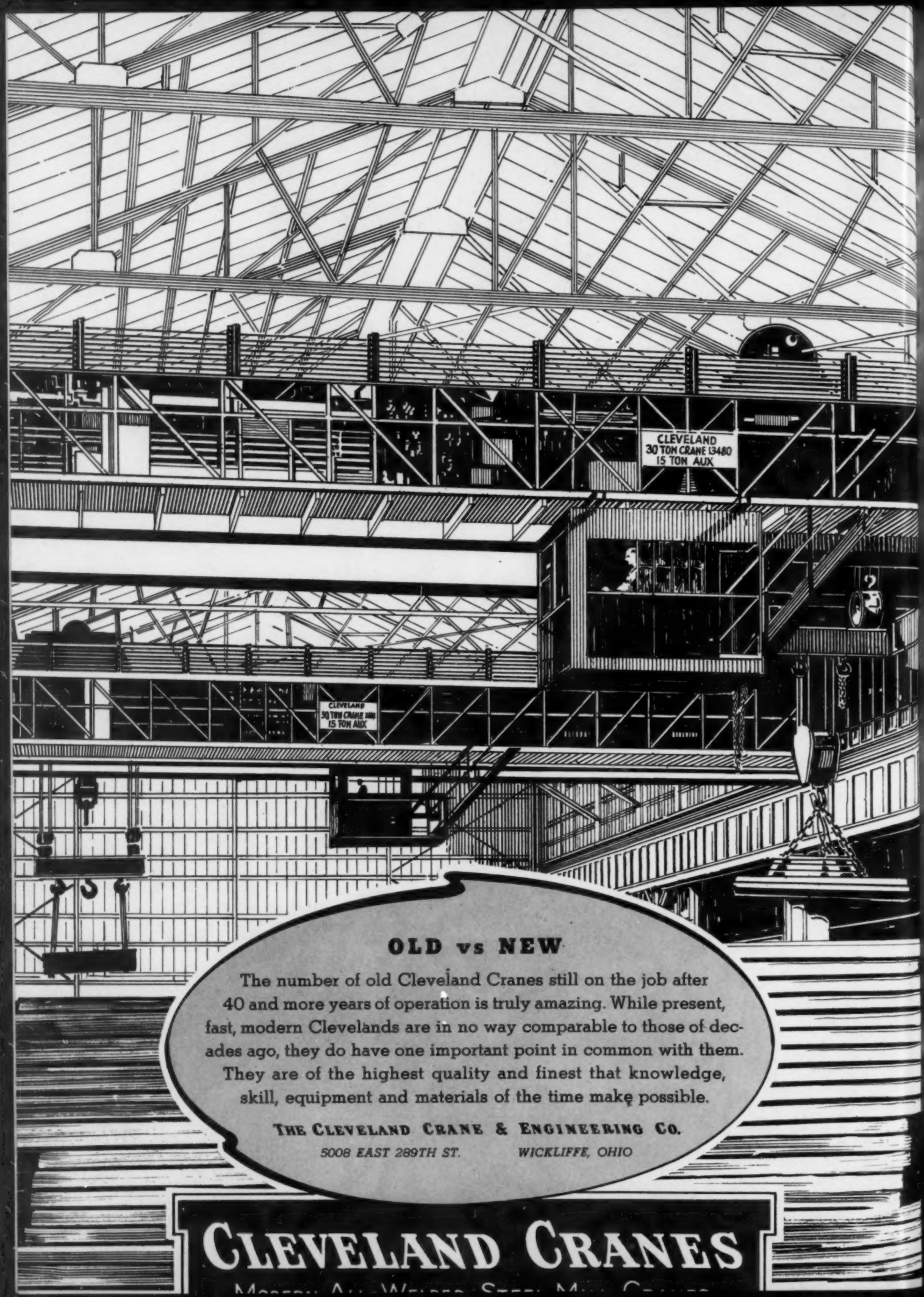

OLD vs NEW

The number of old Cleveland Cranes still on the job after 40 and more years of operation is truly amazing. While present, fast, modern Clevelands are in no way comparable to those of decades ago, they do have one important point in common with them. They are of the highest quality and finest that knowledge, skill, equipment and materials of the time make possible.

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Crops and Shorts

A NUMBER of equipment manufacturers have expressed the belief that the steel industry is spending money needlessly because of an unwillingness to accept standardized equipment. True, there are many engineers who insist on changes based principally from their own whims. On the other hand, much of the "standardized" equipment is not designed to withstand the rugged service or to permit the quick maintenance demanded by the steel industry. In many cases, the engineers of the steel industry have pioneered in standardization of various items of equipment, but in these cases they were able to guide the design so that it fit steel plant conditions. Perhaps equipment manufacturers would do well to submit their tentative designs to representative engineers from the steel industry before standardizing. Then their equipment would meet the requirements of heavy industry, and heavy industry would benefit from standardization.

Much of the equipment standardization work already accomplished in the steel industry has been sponsored by the Association of Iron and Steel Engineers, and the Association stands ready to assist further in such standardization work which will benefit the industry.

▲

THE Census Bureau, trying in a report to explain why the national birth rate went up during the war, reached the conclusion that causes were "allotments to dependents, the emergency maternity care program, and occasional furloughs." Looks as though we'll have to rewrite the biology books.

▲

OVERALL output per man-hour in heavy industry is not rising to any extent, but remains only slightly above the war-time level and approximately 10 per cent lower than in prewar times. On the other hand, wage rates have increased so much that wage costs per unit of product have almost doubled prewar figures. The third round of wage increases now getting under way will aggravate the situation, and will no doubt be followed by further price increases.

The labor government of Great Britain has recognized the danger of such practices, and has ruled that there shall be no further general wage increases without an increase in productivity, and that industries violating this rule will not be permitted to raise prices.

A REPORT by the Machinery and Allied Products Institute on 25 industries in Britain states that production per worker is lower in all cases in Britain than in the United States. Because of superior technological equipment, the American worker produces on an average, about three times as much as the British worker. The report indicates that more than half of the equipment in use today in large segments of British industry was installed before the first world war.

▲

SPEAKING of income tax (as most of us are about now), one wit defines it as the fine we pay for reckless thriving.

▲

EGGS are currently retailing at 80 cents a dozen, but the government is again talking about buying eggs to support their price. This may make sense to some people, but not to us. Why hold up food prices, already disproportionately high, so that wages must be increased, resulting in higher prices of products that will eventually contribute to still higher food prices?

▲

WHILE we shudder at the mass destruction of the atom bomb, we might well pause to reflect that accidents in the United States each year snuff out more lives than did the Hiroshima bomb.

▲

ACCORDING to the Edison Electric Institute, new electric generating capacity to be added to United States systems by 1951 will total 18,000,000 kw. Of this, steam power comprises 15,500,000 kw, hydro-electric power the rest.

▲

IT has been estimated that approximately 4,000,000 tons of steel were sidetracked into the gray market during 1947. Steel allocation as now planned will shorten supplies available to industries not favored by the proposed allocation. Under allocation these industries will certainly fight even harder for supplies of steel, and we might well expect that the gray market will continue to do business in the old stand as long as demand exceeds supply.

▲

WHILE we're wading around in the snow these days, it may be comforting to remember that winter is what we think isn't so bad in the summertime.

▲

BASEBALL has been defined as a game in which the best team loses on account of the other team getting the breaks. This same definition can well be applied to business and all competitive activities. There is probably no man who, in his own opinion, gets all the good things he deserves, or who, in the opinion of his neighbors, deserves all the good things he gets.

▲

HOW many cents a dollar is worth isn't nearly as important as how much sense the person has who spends it.

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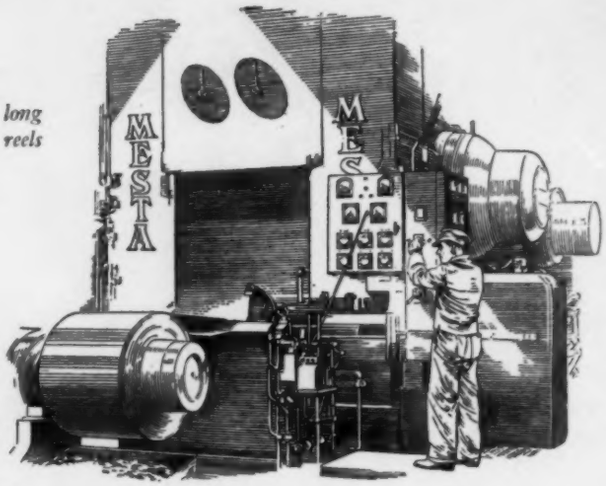

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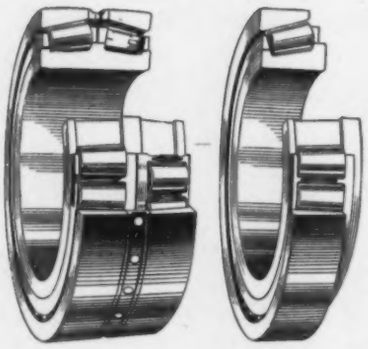

... another advantage is the long service life assured by the high radial and thrust capacity of these Torrington Bearings.

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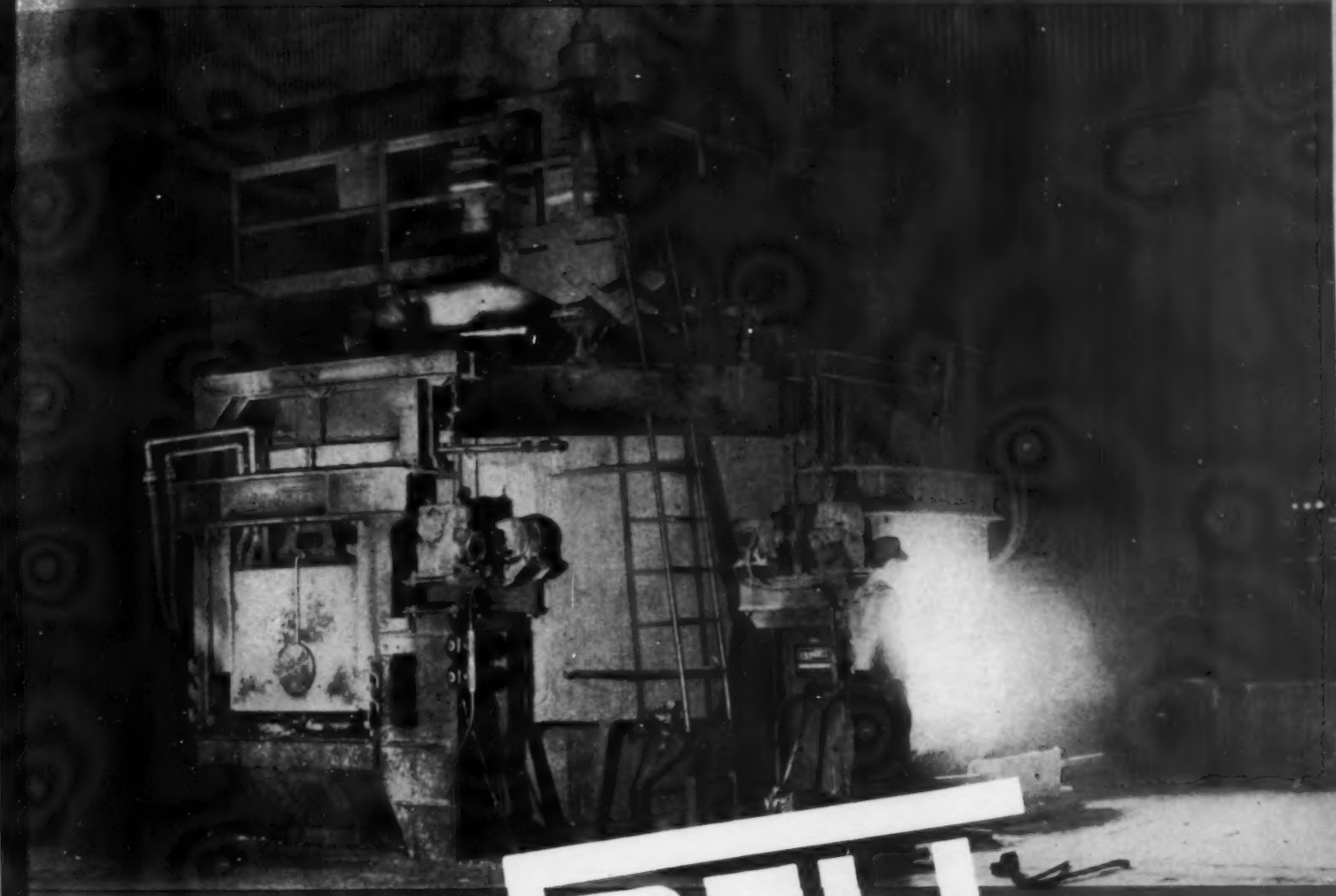

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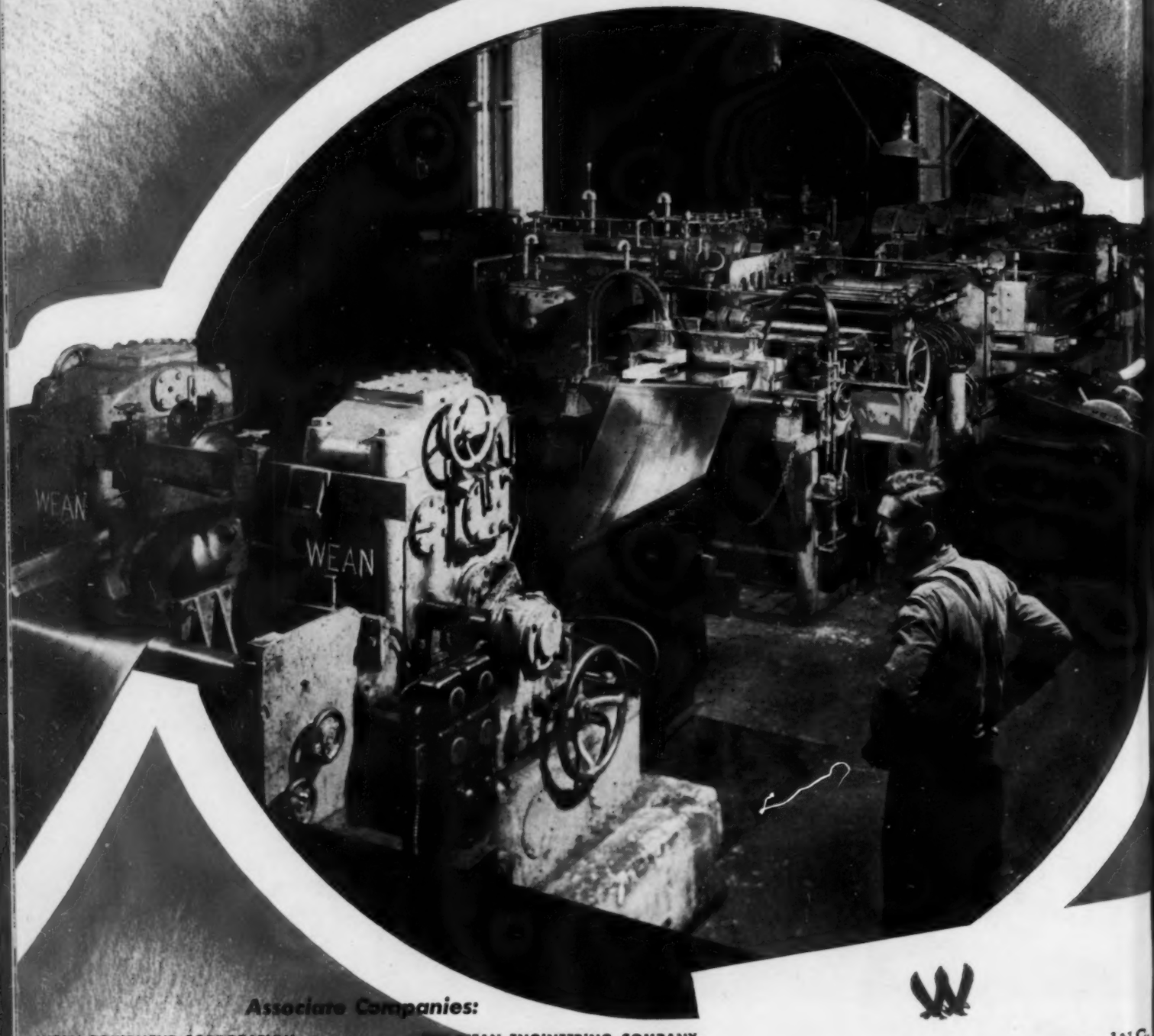

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Iron and Steel ENGINEER

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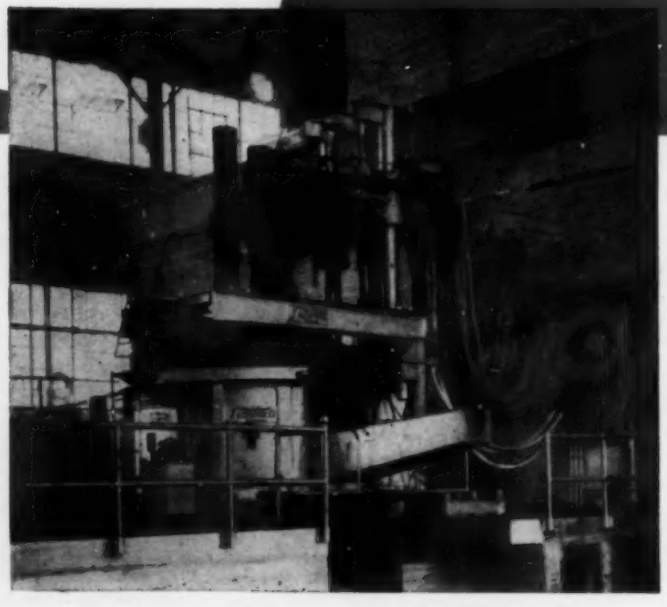

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OXYGEN USES IN STEEL PRODUCTION

. . . . this paper summarizes much of the development and research work which has been accomplished on the use of oxygen in the open hearth . . . .

By J. H. ZIMMERMAN
Manager, Development Division
Linde Air Products Company
New York, New York

▲ DURING the past year there has been a great effort on the part of the steel industry and those associated with it to evaluate the use of oxygen in the open-hearth furnace for metallurgical purposes. A lot of water has gone over the dam since the start of this program, but everybody will agree that there is still a lot more to come. A few things are clear from the data records of over 6000 heats using oxygen which have been run in some 34 furnace shops with which our company has been co-operating. If the answers to other factors have not been found at least the problems have been pinpointed. During this experimental program, the great majority of the oxygen used was the high-purity, 99.5 per cent product, supplied from existing liquid oxygen systems because of its availability in substantially large volumes and ability to serve high demand rates. Low-purity oxygen and even compressed air have not been generally available for this work, although some work has been sponsored to determine optimum oxygen purities. This paper will cover the nature of the experiments and the results obtained with high-purity oxygen. At the Homestead plant of the Carnegie-Illinois Steel Corporation, a really comprehensive program has been under way, investigating a wide range of oxygen-nitrogen ratios for decarburization, and this work, has been reported in the January 1948 *Iron and Steel Engineer.*

The first general observation is that oxygen of some purity will accelerate the melt-down of the scrap charge and will reduce the refining period. However, the percentage gains which can be attributed to proper use of oxygen for melt-down or decarburization do not always add up to a corresponding overall reduction of the charge-to-tap time in the furnace. This can be attributed to the fact that while mills are now well integrated according to present standard steelmaking practices, any factor that tends to increase the output of one phase throws the others out of step. It has been found, for instance, that scrap handling and charging facilities are inadequate to realize the potential production increases available through oxygen use.

The overall economics of oxygen utilization cannot be pinpointed at this time because it has not yet been definitely determined what purity is required for each phase of oxygen utilization, and the oxygen demand rates and overall consumption figures for any given operation are only tentative. As a result of this initial work it has been found that there is a definite refractory problem to be overcome, possibly through modification of furnace design or improved methods of oxygen utilization. Furthermore, oxygen injection during the refining period has given rise to a serious smoke problem. These statements might indicate that not much has been learned, but on the contrary, they should serve to focus attention on the tremendous scope of the problem in the overall picture.

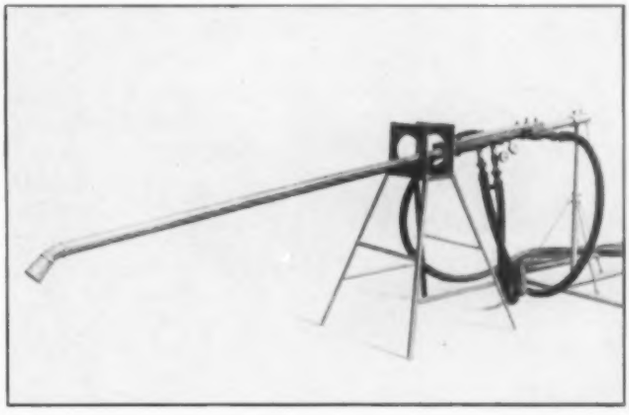
Actually, much valuable information has been accumulated, particularly to point the way toward most efficient ways of using the oxygen in present furnaces. It is the purpose of this paper to sum up in general these findings.

OXYGEN FOR CARBON REDUCTION

It is probable that more heats have been run for carbon reduction during the refining period than on any other application, because of the apparent simplicity of the application and the attractive gains to be achieved. In normal ore practice, carbon reduction rates average on the order of ½ point per minute; whereas, using oxygen in the range of 100 to 300 cubic feet per ton of metal, this carbon reduction rate has been accelerated 2 to 5 times.

In early work the oxygen was introduced into the bath by an ordinary one inch pipe lance, the pipe being

Figure 1 — From 500-2000 gphr cooling water is required for this jet device which was built for an oxygen flow rate of 3000-70,000 cufthr.



Presented before AISE Annual Convention, Pittsburgh, Pennsylvania, Sept. 23, 1947.

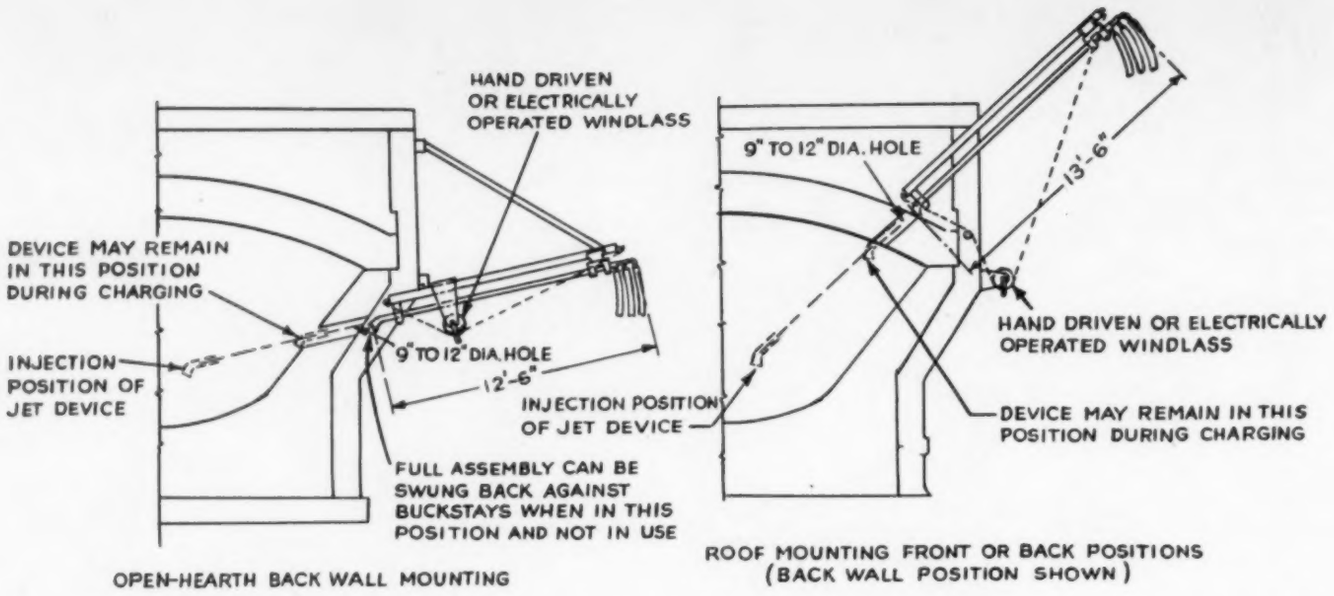


Figure 2 — Two possibilities for permanently mounting jet devices in the open hearth are suggested by these sketches.

held manually and inserted through the wicket holes of the furnace door. Until the proper technique was evolved, 20-foot lengths of lance pipe were burned up in the order of 2 to 3 minutes because it was believed necessary to push the end of the lance well down into the molten metal. The lance was therefore burned off practically as fast as it could be forced into the bath. However, either by accident or design, it was found that lance-pipe life could be increased to as much as 1½ hours by inserting the end of the lance to the slag metal interface only. Even with this increased lance life, it is still necessary to interrupt the carbon reduction period when changing to a new length of pipe. There was also the problem of cleaning these pipes for oxygen service to prevent flashbacks due to the combustion of oil or grease on the inner pipe surface. The procurement of sufficient quantities of lance pipe for large scale operations is likewise no minor problem at the present time.

Lances have been and still are worked from the front of the furnace through the wicket holes of the furnace door, although the manual labor has been minimized considerably by holding the lance pipe on a small two-wheeled stand which is moved forward as the lance burns off. In practically all cases, the oxygen supply hose to the lance is run across the charging floor to the oxygen supply outlet.

This working of the furnace from the front side, with hoses strung across the charging floor, either seriously interferes with charging operations at other furnaces if it is desired to inject the oxygen continuously, or results in interruption of oxygen injection to permit passage of charging machines and scrap buggies. All this does not constitute too serious a problem on experimental work where only 1 or 2 furnaces might be using oxygen or even, for that matter, in a production operation in open-hearth shops having relatively small numbers of furnaces. It presents a major problem, on the other hand, if consideration is given to oxygen lancing operations on a production basis in a furnace shop of 12 to 16 furnaces.

With this major limitation in mind, the idea was conceived of a non-consumable oxygen injection device which would be adaptable to mechanization. The first practical embodiment of this idea is shown in Figure 1 which illustrates a water-cooled jet device. The model shown is the net result of experience gained in three previous designs, the problem being to provide adequate cooling to the replaceable insert nozzle. This is accomplished by large, closely machined seating surfaces to assure adequate heat transfer between the directly water-cooled nozzle holder and the nozzle. Of course, when oxygen requirements are well defined for a particular application, integral nozzle construction can be used. The nozzles are designed to operate in a pressure range of 75-110 psi. The water is introduced at the rear end of the jet, is delivered to the front end on the inside of a tubular baffle and returns to the rear discharge outlet between the baffle tube and the outer shell of the device. This arrangement provides the coldest possible water at the front end.

There was great reluctance on the part of the steel industry to use any water-cooled equipment which would be inserted below the slag or metal surface. It was believed that if any failure occurred in the shell of water-cooled equipment thus permitting water to escape below the molten-metal surface that steam would immediately be generated in explosive proportions because of the extremely high temperatures involved, and a great hazard would result to both the operators and the furnace. For this well-founded reason, the method for introducing the oxygen into the molten metal with the jet differs radically from that of the lance, and is a distinct innovation. The end of the jet device is maintained some 3 to 6 inches above the slag surface and the oxygen is forced into the metal through the use of a supersonic velocity oxygen stream. The supersonic velocity is imparted by the nozzle design and the pressure. The nozzle is the divergent type, and velocities in the order of 1300-1500 feet per second are obtained. Under these conditions of high velocity, the oxygen stream pierces the overlying slag layer and

blows well down into the molten steel. Agitation throughout the bath is thus produced. To obtain experimental evidence on the operation of the jet device, and its possibilities for mechanization of the operation, this equipment has been operated through the wicket holes of the furnace doors in much the same manner as the lance, with the oxygen supply hose and water inlet and discharge hoses running across the charging floor to their respective outlets. It is fully realized that the jet device operated in this manner is no more suitable for large scale production operation than conventional lance practice. However, this has been done to accumulate operational information with the minimum expense to the mill.

This experimental program has proved that the idea of non-consumable oxygen injection apparatus is practical, even under the most severe heat conditions encountered in the open hearth. The next step is to mechanize this jet device. Preliminary studies of this problem indicate that mechanization through the front wall is impractical because it would be virtually impossible with present furnace construction to build a mechanism which would not interfere with the passage of scrap-filled charging boxes. Introduction through the end of the furnace is also very difficult because of the excessively long jet device that would be required, plus the lack of convenient working space between furnaces in most shops. This leaves then, only the roof and the back wall to be considered. Openings in the roof to permit introduction of the jet have been frowned upon by open-hearth operators, because even now the roof is the weakest part of the refractory structure of the furnace. It is thought that any such opening would make the roof even more susceptible to damage.

These considerations leave the back wall as the most practical location for a mechanized jet. Even in this case, careful and individual consideration must be given to each specific application because of variations in back-wall design and pouring-platform space limitations. Any job would have to be so engineered so as not to encroach on the normal activity on the pouring side of the furnace.

Mechanization should remove much of the human element from the oxygen-injection operation, while at the same time relieving the furnace operator of the hot and exhausting job of working a lance or jet from the front side of the furnace. It is possible to conceive of an installation where, by merely pressing a button, a jet device would be inserted into the furnace and the oxygen and water turned on automatically through limit switch control. This would make oxygen injection another simple and easily handled tool in the grasp of the first helper. To date no such highly idealized installation has been made, but several of a simpler nature are in the process of preparation.

One simple method for jet device introduction is shown in Figure 2, where ample space is available on the back side of the furnace. The jet device is guided in and out of the furnace and supported from an I-beam or pair of channels. The device is controlled by a continuous cable which may be motor or manually operated. Interlocking controls may be added to prevent introduction of the jet until cooling water has been turned on.

Another method, proposed by Republic Steel Corporation, Buffalo, is shown in Figure 3 which would apply when space on the back side of the furnace is restricted. This is essentially a four-bar linkage with a movable pivot. In the retracted position, the jet is stored vertically against the back wall and is swung in an arc through a vertical rectangular opening into the furnace.

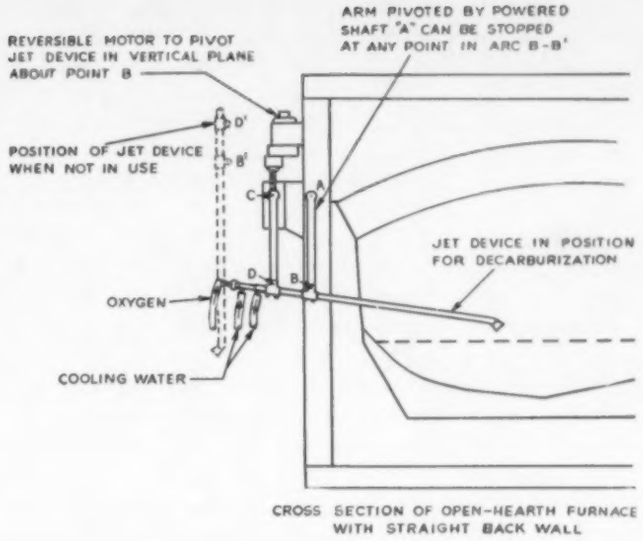

ARM PIVOTED BY POWERED SHAFT "A" CAN BE STOPPED AT ANY POINT IN ARC B-B'
REVERSIBLE MOTOR TO PIVOT JET DEVICE IN VERTICAL PLANE ABOUT POINT B
POSITION OF JET DEVICE WHEN NOT IN USE
D'
B'
C
A
JET DEVICE IN POSITION FOR DECARBURIZATION
D
B
OXYGEN
COOLING WATER
CROSS SECTION OF OPEN-HEARTH FURNACE WITH STRAIGHT BACK WALL

Figure 3 — When there is limited room on the back side of the furnace, this method of mounting the jet may be feasible.

From an operational standpoint, the results obtained with the lance and jet are about on a par. There are no conclusive data that show definitely that the lance is better than the jet, or conversely that the jet is better than the lance.

Data shown in Table I do indicate interesting comparisons between lance and jet operations in a 220-ton furnace under approximately similar conditions. The oxygen injection rate with the lance was 3 times greater than that with the jet device, but the overall carbon reduction rate with the lance was only twice that obtained with the jet device. The percentage increase in charge-to-tap time was approximately the same. Also, it is to be expected that the overall carbon reduction rate with the lance in this example would be somewhat higher than obtained with the jet, since reduction was

TABLE I

	Jet device	Pipe lance
Type of steel	Low carbon	Low carbon
Heats averaged	8	29
Yield with oxygen	22.3	24.6
Yield without oxygen — tons/hour	17.3	18.2
Percentage increase	28.9	35
Oxygen injection rate — cufthr	20,200	63,600
Oxygen consumption — cu ft/ton of steel	112	270
Oxygen efficiency — cu ft/point carbon reduction/ton of steel	1.73	2.4
Initial carbon — points	83	127
Final carbon — points	17	14
Rate of carbon reduction — points/min	0.9	2.0
Charge-to-tap time with oxygen — hr	10.1	8.9
Charge-to-tap time without oxygen — hr	13.0	12

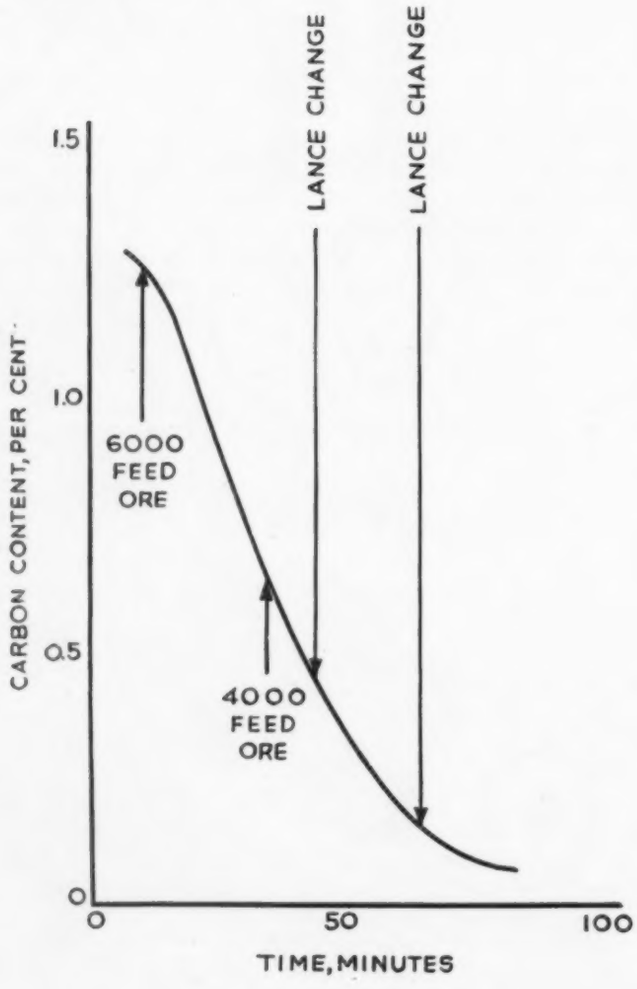
started from a higher carbon content. A further indication of the relative effectiveness of lance and jet injection is indicated in Table II secured in the operation of a 225-ton open-hearth furnace in practically identical carbon ranges. This particular record shows that the rate of oxygen injection through the lance was approximately double that through the jet device. However, the rate of carbon reduction obtained with the lance was only 30 per cent higher than with the jet. On the other hand, it has been claimed by some furnace operators that the jet is not as efficient as the lance in achieving very low finishing carbons in the order of 2 to 3 points.

These data show an oxygen efficiency varying from 1.7 to 3.2 cubic feet per point per ton. The amount of oxygen theoretically required for reduction of carbon content by one point is 3.2 cubic feet per ton of steel. The difference between this and actual figures is an indication that advantage is gained from the agitation produced in the bath, accelerating the interaction of the ferrous oxide in the slag with the base metal.

TABLE II

	Jet device	Pipe lance
Type of steel	Low carbon	Low carbon
Heats averaged	7	7
Percentage increase in production	10.3	6.9
Oxygen injection rate — cufthr	22,200	46,700
Oxygen consumptions — cu ft/ton of steel	102	163
Oxygen efficiency — cu ft/point carbon reduction/ton of steel	1.7	3.2
Initial carbon — points	77	72
Final carbon — points	18	16
Carbon reduction	59	56
Rate of carbon reduction — points/min	0.9	1.2
Charge-to-tap time with oxygen — hr	10.0	10.3
Charge-to-tap time without oxygen — hr	11	11

Figure 4 — Curve showing oxygen decarburization through lance pipes. The following data pertains to the curve: average points carbon removed — 109; average time of injection, minutes — 67; average rate of carbon removed, points carbon per minute — 1.64; cu ft oxygen used per heat — 64,000; average ingot tons per heat — 221; cu ft oxygen used per ton — 290; cu ft oxygen used per point carbon removed — 585; cu ft oxygen used per point carbon removed per ton — 264. Two lances were used simultaneously through two wicket holes. At first point marked "lance change" both lances were replaced by a second pair. These in turn were replaced by two lances which were only partially consumed at the termination of oxygen injection.



Examination of the average carbon-time reduction curves for the lance in Figure 4 and for jet operation in Figure 5 shows that for a substantially constant rate of oxygen injection, the rate of carbon removal decreased progressively as the carbon content is reduced. If it were desired to hold a reasonably consistent rate of reduction, it would be necessary gradually to increase the oxygen flow as the carbon content is reduced. This practice is being used in some shops, although the main reason is to obtain better control of the splash resulting from the oxygen injection. It has been established that there is a decrease in the life of the furnace refractories due mainly to splashing from oxygen injection, although actual quantitative figures have not been determined. The splash is much more severe in the high carbon ranges than in the range of 20 points and less, and the degree of splash is directly related to the oxygen flow rate. Taking cognizance of this fact, only moderate oxygen flows are used in the higher carbon range but the flow is increased when the carbon content drops below 20 points. For example in a 100-ton open hearth; the starting oxygen flow is about 25,000 to 30,000 cubic feet per hour, which is later boosted to 50,000 or 60,000 cubic feet per hour. When using a lance this flow range is obtained by varying the inlet pressure. With jet operation this flow range is obtained by using one jet device with a nozzle having a rated flow of 25,000 cubic feet per hour for the high-carbon range. A second jet with an identical nozzle is inserted to achieve the final carbon reduction. This practice tends to minimize the splash problem while at the same time achieving a satisfactory overall carbon reduction rate. No tests have been made with more than two points of oxygen injection, although it is possible that this may provide an answer to the splash and refractory problem during the refining period and give a more efficient distribution of oxygen in the bath.

The character of the splash obtained from the lance or jet device has been and still is under study principally by means of motion pictures.

The lance when held at the slag-metal interface tends to throw a relatively solid stream of metal and slag

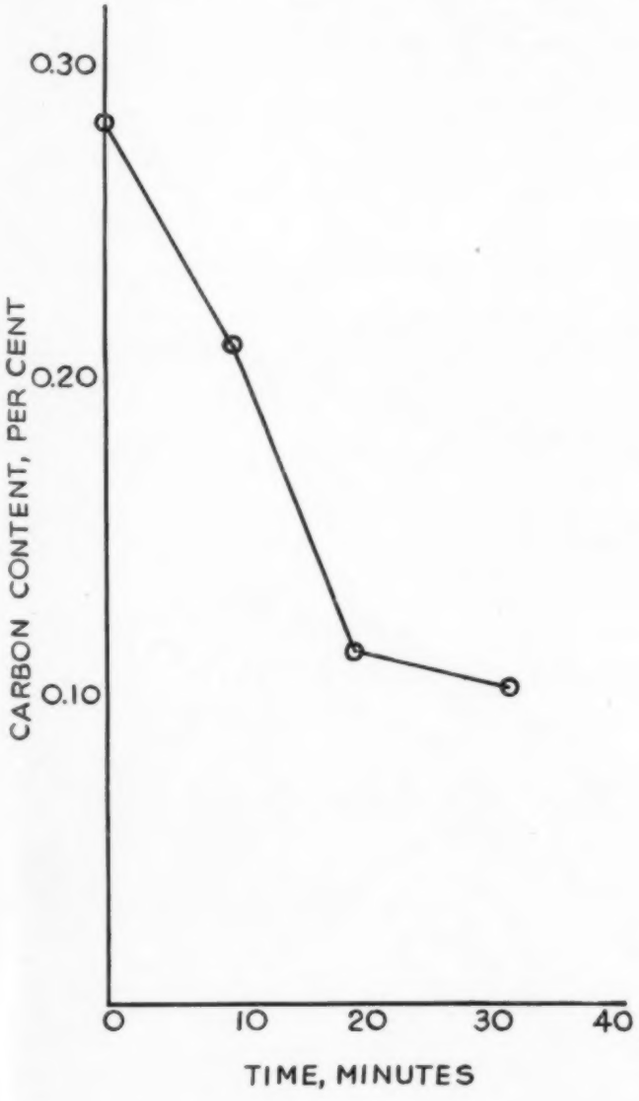
towards the back wall. With the jet, on the other hand, the splash is more finely divided and is directed roughly counterflow to the oxygen stream. By proper orientation of the jet within the furnace, the splash can be made to fall along the long axis of the bath.

The splash and agitation of the bath is accompanied by the evolution of large quantities of brown fumes consisting of iron oxide, manganese oxide, and calcium silicates. Considerable success in smoke elimination has been achieved by the installation of simple dust collectors in the flue system, and by changing checker construction to provide additional gas space. The checkers must be blown more frequently to keep from plugging.

Another factor which may aggravate the refractory problem, if not properly controlled, is the heat pick-up of the bath during oxygen injection. In normal ore practice, the reaction between the ore and carbon is endothermic which more than counterbalances the exothermic oxidation of the silicon, manganese, and phosphorus in the hot metal, so that heat must be added to the bath from the end burners to maintain proper temperature. On the other hand, oxygen injection into the bath for carbon reduction is accompanied by a rise in bath temperature. Heat input from the main burners is reduced from about half normal flow at the start of oxygen injection to zero as the bath and furnace gain temperature. The temperature of the bath may also be controlled by the cooling effect of ore additions. The combined use of ore and oxygen will give the furnace operator a means for raising or lowering bath temperature. Furthermore, when quantities of ore have been injected into the bath along with oxygen use, to permit a gradual, instead of quick rise in bath temperatures, considerably increased rates of carbon reduction have been observed. These rates actually were higher than when oxygen was used alone as the carbon reduction medium.

Injection of oxygen into the bath is most useful in shops employing large amounts of hot metal in the charge, and in shops producing low-carbon steel.

Figure 5 — Curve showing decarburization with jet device. The following data applies to the curve: cu ft oxygen used — 13,800; oxygen flow rate through jet, cfhr — 25,000; cu ft oxygen used per ton — 63; cu ft oxygen used per point carbon removed per ton — 3.5.



OXYGEN FOR SCRAP MELT-DOWN

The other major field for which oxygen has been used is during the melt-down period. This is being investigated from two different angles: using the oxygen in conjunction with the fuel stream to increase the rate and intensity of combustion, and using the preheated scrap as its own fuel by directly oxidizing it with a controlled oxygen stream.

The use of oxygen for combustion purposes has been closely integrated with the problem of burner design to attain the most efficient utilization of the oxygen. Practically all work has been done on oil or tar-fired burners. It is believed that the design first tested to any great extent in the steel industry was that having an annular passage around the fuel pipe to supply a low-velocity sheath of oxygen around the fuel stream.

In order to study the flame characteristics of variations in burner design a brick-lined test kiln was built at our research laboratory at Tonawanda, New York. This test kiln, shown in Figure 6, was supplied with tar and oil pumping facilities, unpreheated secondary air from a large blower, and adequate oxygen supply. It was fully realized that this test kiln did not duplicate the heat radiation conditions found in the open hearth, but it did provide a means for qualitatively comparing design variations. Full scale furnace tests were made on only the most promising designs. Actually most of the burners tested were of the auxiliary type (essentially miniature end burners).

Auxiliary burners — The thought behind the use of auxiliary burners was to provide maximum heat transfer by impinging high-temperature, high-intensity flames directly on localized areas of the scrap charge, augmenting the action of the end-burner flame. The auxiliary oxygen-fuel burners were first tried out in the 4-ton open hearth at the Jones and Laughlin Steel Corporation laboratory by inserting the burners through the wicket holes and playing the flame on unmelted portions of the scrap charge at a working distance of 10 to 30 inches. A reduction of about 30 per cent charge-to-tap time was obtained by use of these auxiliary burners in the 4-ton furnace as compared with the time required for normal practice heats in which the natural

gas-air burner alone was used during melting. These heats used 1860 cubic feet of oxygen per ton of steel.

As a result of these favorable tests, 6 heats were run in a 175-ton furnace with the burners inserted through the roof. An average saving of 1.6 hours charge-to-tap time with an oxygen consumption of 200 cubic feet per ton was made. It was found, however, that when the high-velocity auxiliary flames were used, the end-burner flame was deflected causing pronounced erosion of the refractories. Lower-velocity flames from the auxiliary burner were deflected by the oil-air flame from the main burners, so that the auxiliary flame did not impinge on the scrap, defeating the purpose of the oxygen addition. This method must still be considered experimental; further development will depend on design of practical means for mounting and mechanizing the burners for roof, back-wall, or front-wall installation.

End burners — The fundamental data on atomization, flame length-temperature relationships, heat transfer, and general burner performance obtained by the auxiliary burner work have proved useful in improving the end burner. This has culminated in the type of burner having a single high-velocity oxygen stream below the fuel jet. The nozzles used to impart the high velocity (supersonic) to the oxygen stream are similar to those used in the jet devices. The burner is completely water-cooled so that it may be operated without a doghouse in the furnace.

With this design there is a marked increase in flame radiation and luminosity on the underside of the flame (Figure 7) which either directly contacts or radiates to the scrap charge. The top side of the flame approaches the flame condition without oxygen so that radiation to the roof is less than to the scrap charge. Measurements of flame radiation have shown that the oxygen through the end burners will increase the radiation from the flame from about 10 per cent through the major volume of the flame to over 20 per cent at the charging door nearest the burner. This radiation increase drops to 5 per cent at the charging door at the opposite end of the furnace. Care must be exercised to avoid cutting of walls or roof by deflected high-temperature flames.

That there is intensification of the combustion rate can be seen by the fact that the flame length is decreased by 30 per cent. For example, a burner being fired without oxygen at 350 gallons per hour of fuel had a flame approximately 50 to 55 feet long, whereas a flame from the undershot type of burner with a flow of 500 gallons per hour of oil and 25,000 cubic feet per hour of oxygen had a flame 35 to 40 feet long. This shortening of the flame, even with increased fuel consumption, means that the combustion rate in a given flame can be increased when oxygen is used without having combustibles in the down-takes. The high combustion rate obviously leads to an increased rate of scrap melt-down. During oxygen use, it is normal practice to reduce the air input to the checkers to compensate for the oxygen being supplied through the end burner so that the stack gases will contain the normal 1 to 2 per cent of oxygen. Actual flame temperatures are not known with any great degree of accuracy, although theoretical considerations would indicate that the flame temperature will increase in the neighborhood of 200 to 400 F with oxygen enrichment.

A study of the records of 728 heats (Table III) shows that a 10 to 25 per cent reduction in heat time has been obtained with an oxygen consumption through end

Figure 6 — A test kiln was built in the research laboratory to study the effects of burner design on flame characteristics.

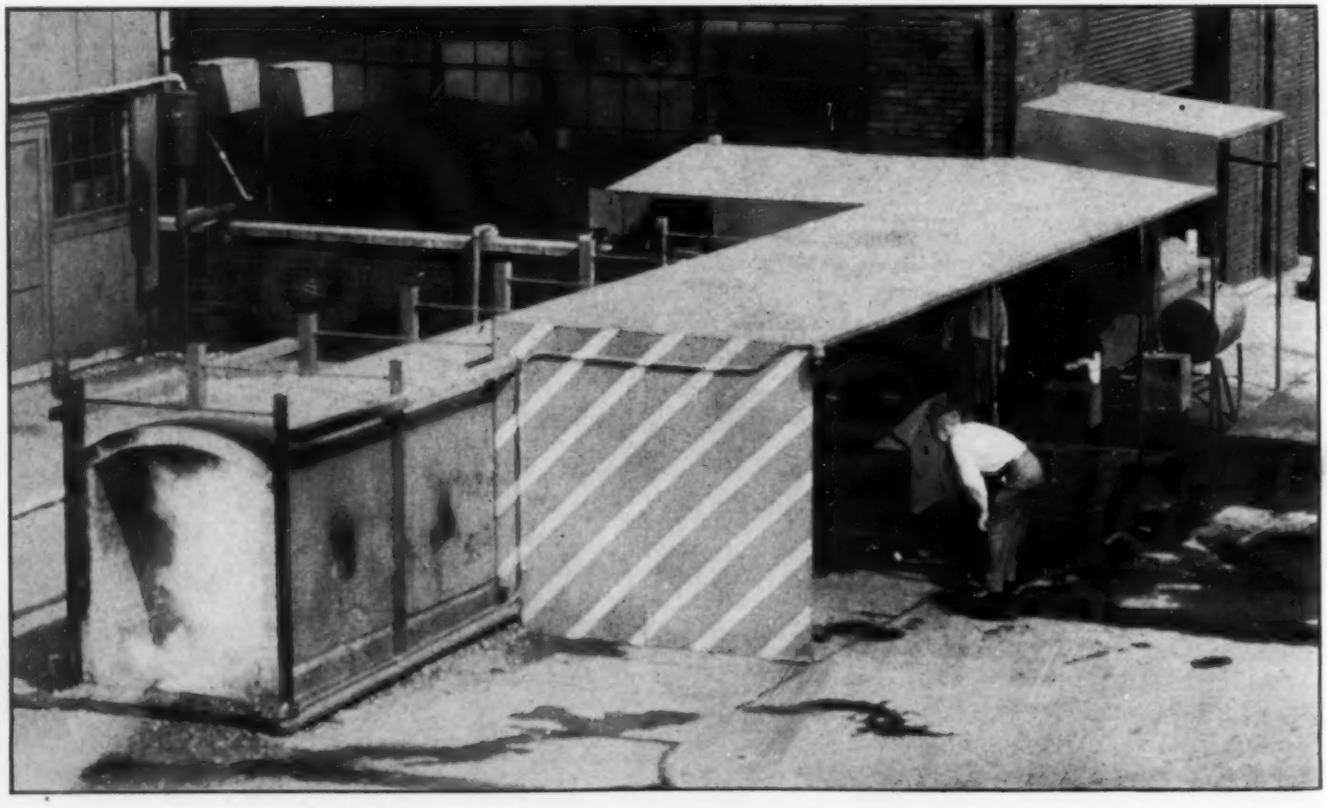


TABLE III

SUMMARY OF OPEN HEARTH HEATS USING OXYGEN THROUGH END BURNERS

Mill	A	A_1	A_2	A_3	A_4	A_5	B	C	C_1	C_2	C_3	C_4	D	E	F	G	G_1	H	H_1
Size of heats tapped, tons ingots	64	219	225	227	228	224	173	201	198	196	201	197	100	183	124.4	126	130	236	232
No. of O_2 heats avgd. for data below:	20	20	13	28	64	47	53	48	58	30	102	31	23	20	18	8	4	21	120
Total No. of Heats - 726																			
Average charge: Percent scrap	60	60	60	60	60	60	61	22	35	22	32	22	40	53	51	32	49	60	58
Percent molten metal	--	40	40	40	40	40	39	78	65	78	68	78	52	47	44	53		37	37
Percent cold pig	40	--	--	--	--	--	--	--	--	--	--	--	1	--	--	4	47	3	5
Percent ore	--	--	--	--	--	--	--	--	--	--	--	--	7	--	5	11	4	--	--
Fuel	Tar	Tar	Tar	Tar	Tar	Tar	Oil	Oil	Oil	Oil	Oil	Oil	Oil	Oil	Oil	Oil	Oil	Oil	Oil
Practice	C.Metal	H.Metal	H.Metal	H.Metal	H.Metal	H.Metal	H.Metal	H.Metal	H.Metal	H.Metal	H.Metal	H.Metal	H.Metal	H.Metal	H.Metal	H.Metal	C.Metal	H.Metal	H.Metal
Mil.-B.t.u.'s/ton, tap-to-tap, with O_2	4.5	2.87	3.77	4.33	3.69	4.17	3.94	3.99	--	3.02	4.75*	2.85*	--	--	3.66	3.45	4.31	4.16	4.59
Mil.-B.t.u.'s/ton, tap-to-tap, without O_2	4.5	3.60	3.60	4.25	4.34	4.34	3.95	3.85	3.85	3.85	--	--	--	--	--	--	--	--	--
Fuel-gph. during meltdown, with O_2	282	458	462	506	493	530	556	--	--	--	--	--	381	490	375	393	383	681	651
Fuel-gph. during meltdown, without O_2	160	330	330	360	--	--	415	--	--	--	--	--	320	430	333	--	--	--	--
Average O_2 flow, cfh.	31,400	51,000	55,700	26,600	36,600	25,200	47,100	93,840	**	**	**	**	25,700	23,900	16,400	14,250	16,700	48,500	21,050
Duration of O_2 flow, hours	3.3	3.5	4.1	4.1	5.0	3.6	3.2	2.0	--	--	--	--	2.7	3.4	2.6	3.6	5.5	4.0	4.4
Total O_2 used, cu.ft./heat	103,600	178,100	228,900	107,600	182,200	90,700	150,800	87,700	177,800	217,400	194,500	242,000	69,300	81,200	42,000	51,400	91,800	194,300	92,300
Total O_2 used, cu.ft./gal.fuel (during melt)	111	111	120	53	74	48	83	--	--	--	--	--	67	49	43.7	36	44	71.2	52.4
Total O_2 used, cu.ft./ton of ingots	1610	811	1020	474	799	405	871	436	898	1110	969	1228	693	462	337	443	705	822	398
Oxygen other than burner use, cfh.	--	--	--	--	--	--	--	--	47,900	132,400	71,500	146,500	--	--	--	--	--	--	--
Chg.-to-tap time in hours, with O_2	8.2	9.6	11.9	14.90	11.37	12.95	10.4	11.0	11.36	8.95	12.00	9.18	7.2	9.1	8.7	7.4	10.1	13.7	14.7
Chg.-to-tap time in hours, without O_2	11.8	13.2	13.2	15.22	15.55	15.55	13.4	12.0	12.00	12.00	12.00	12.00	8.7	11.0	11.5	9.9	13.0	15.2	15.4
Percent decrease, with O_2	31	27	10	8.8	26.9	16.7	22.0	8.0	5.32	25.4	0	23.5	17.3	17.3	24.2	25.3	22.3	9.9	4.5
Time to charge scrap	--	2.5	3.0	4.4	3.25	4.2	--	--	--	--	--	--	--	--	--	--	--	4.6	4.8
Tap-to-tap time in hours, with O_2	9.1	11.2	13.9	15.57	13.75	14.62	12.0	--	--	--	--	--	--	10.6	9.2	--	--	15.3	16.1
Tap-to-tap time in hours, without O_2	13.6	14.5	14.5	17.30	17.12	17.12	--	--	--	--	--	--	--	--	12.0	--	--	16.7	16.8
Percent yield, average with O_2	--	--	--	--	--	--	85.8	90.6	--	--	--	--	87.5	87.5	--	83.5	90.0	--	--
Percent yield, average without O_2	--	--	--	--	--	--	85.4	91.0	--	--	--	--	--	--	--	--	--	--	--
Tons/hr. charge-to-tap, avg. with O_2	7.79	22.9	18.9	16.35	20.03	17.30	16.6	18.2	17.4	21.85	16.75	21.45	13.9	20.1	14.2	17.0	12.9	17.3	15.8
Tons/hr. charge-to-tap, avg. without O_2	5.42	16.6	16.6	14.73	14.16	14.16	12.9	16.7	16.7	16.7	--	--	11.5	16.7	10.8	12.7	10.0	15.6	15.1
Percent increase in production	43.7	38.0	15.8	11.0	41.5	22.2	28.7	8.9	4.2	30.8	--	--	20.8	20.3	31.7	33.8	29.0	10.9	4.6
Merit Factor	1.9	3.3	1.0	1.9	3.4	4.1	2.5	1.8	0.6	2.3	0	1.9	2.5	3.8	7.2	5.7	3.2	1.2	1.3

* Based on charge-to-tap time

** No average rate or time of use available

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Revised: April 9, 1947

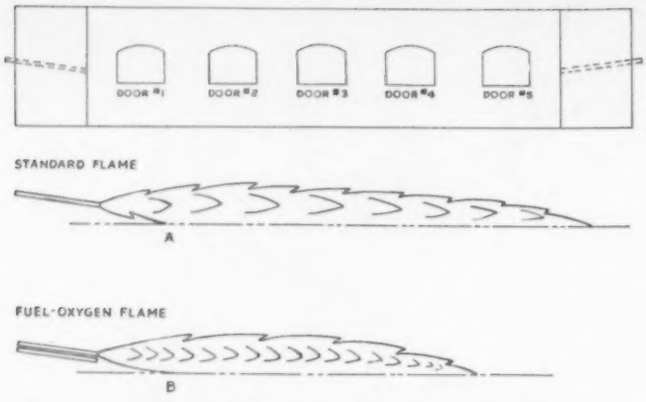

Figure 7 — The enriched flame gives more efficient combustion as shown by the shorter flame length. The enriched flame is about 38 ft long, 3 ft high, burns 500 gphr fuel, requires 1100 lb steam and 25,000 cu ft O_2 per hour, compared with the standard flame which is 53 ft long, 3 ft high, burns 350 gphr fuel, and requires 1100 lb per hr of steam.

burners of 400 to 750 cubic feet of oxygen per ton of steel per heat. Oxygen flows have been varied from 10,000 to 95,000 cubic feet per hour, the preferred flow range being between 15,000 to 50,000 cubic feet per hour. To take advantage of this possible production gain, the scrap must be supplied to the furnace at a rate at all times equal to the melting rate if oxygen is to be used to its greatest advantage. Actually few shops are in a position to do this and in many cases it is necessary to favor the furnace with respect to charging to obtain a picture of the ultimate benefit obtainable with oxygen. In one particular case, where the 125-ton furnace was favored throughout, a production increase of 32 per cent was obtained using 337 cubic feet of oxygen used per ton.

Because of the rapid melting obtained with the oxygen end burner there is less oxidation of the scrap charge. Consequently, it is generally found that the heat will melt-in at a higher carbon content than normal. This makes it necessary to make adjustments in the ratio of hot metal, scrap, and ore to restore normal operating conditions. It is possible that the sulphur content of the steel will be somewhat lower than normal since it will be exposed to the flames for a shorter period of time, although data to substantiate this belief are not quantitatively established. In some cases, when applied to furnaces at the end of a campaign, it has been possible to "sharpen" the operation in the furnace and obtain as much as 30 additional heats. Foaming slags have also been effectively combated with end burners by continuing the oxygen flow when this condition arises to transfer more heat to the slag, and thereby increase the slag temperature and reduce the slag viscosity. All reports indicate that steel produced in furnaces with oxygen-enriched flames is normal in metallurgical quality.

Oxygen for combustion purposes has also been supplied through the checkers to raise the oxygen content of the checker air to 23-25 per cent. With a combustion air rate of 800,000 cubic feet per hour, 40,000 cubic feet per hour of high-purity oxygen is required to raise overall oxygen content of the air to 25 per cent. Results on this application are not conclusive, and quantitative data are lacking as to the actual gains to be expected; however, certain advantages have been claimed, such as increased rate of scrap melt-down, reduction of foam and frothing of the slag, increased temperature rise just before tapping, and a more rapid rise in temperature of quiet heats where the bath is not agitated sufficiently for satisfactory heat transfer from the normal burner flame. It is believed that these improvements result from increased flame radiation because of higher luminosity, and the ability to increase fuel input to the furnace because of more rapid combustion. This method has not been extensively used because similar quantities of oxygen used in the end burner have effected greater savings in charge-to-tap time.

Direct scrap melt-down — The melting of scrap by impinging a high-velocity oxygen stream on the preheated scrap is a new approach to the problem of reducing the melt-down time in the open hearth and is based on the exothermic reaction between iron and oxygen. With this method the scrap itself is its own fuel. The action of the high-velocity oxygen stream is similar in principle to an oxygen jet cutting a piece of carbon steel. A water-cooled jet device identical to those used for carbon reduction is employed to introduce the oxygen stream. For the process to be effective the scrap must be preheated to at least 2500 F. The general effects are first, to rapidly cut down exposed portions of the scrap, producing small amounts of superheated molten scrap steel and oxide, and second, to clear a path for the main burner flame, increasing the area of charge exposed to the flame and thereby improving overall heat transfer from the main flame.

The molten steel and oxide resulting from this action trickles down through the scrap charge, transferring the bulk of its available heat to the mass of the charge. The quantity of heat transferred in this manner is relatively small in comparison to the total heat required to process a charge in the open hearth. But as normally less than 25 per cent of the main-burner heat input is absorbed by the charge, it follows that heat added directly to the scrap in this manner is several times more effective in melting scrap as the same quantity of heat liberated from the main burners.

Considering the fact that one cubic foot of oxygen will oxidize about 0.3 pounds of iron producing approximately 600 Btu of available heat, only 5 per cent of the scrap charge must be oxidized to provide sufficient heat to transform the remaining scrap from the solid to molten state, assuming that the charge had already been heated to 2700 F. In actual practice much less than this is oxidized because the continued heat input from the end-burner flame supplies much of the needed heat. The scrap oxidation with oxygen serves to supply an additional boost of heat to overcome the latent heat of fusion. A large part of the oxide produced in this melting-down operation is probably converted back to metallic iron during the refining period by oxidizing carbon from the bath. This is corroborated by experimental evidence showing that the percentage yield of metallic charge is the same with or without oxygen scrap melt-down.

This rather attractive appearing method of oxygen utilization is not without certain risks. If the furnace brick work is not up to temperature, or if the scrap is

not properly preheated, it is possible to approach a freeze-up condition on the bottom of the hearth.

In practice, the jet device is inserted successively through each wicket hole for about 5 minutes each after the scrap has been preheated to about 2500 F. While only a relatively small number of heats have been made using this technique, an oxygen consumption of only 22 to 36 cubic feet per ton of steel has shown a reduction in charge-to-tap time of 15 to 25 per cent.

This application warrants considerable further attention in view of the small quantities of oxygen required. Of course, the present experimental work has been done with high-purity oxygen. It is quite possible that a technique of direct oxidation will not be as amenable to lower-purity oxygen as the other methods of oxygen utilization.

The use of oxygen directed on the preheated scrap to accelerate charge melt-down has proved to be most effective in shops which use 35 per cent or more of cold scrap, and for shops which contain relatively old inefficient furnaces.

In closing it should be stated that to date only several of the smaller shops are using oxygen in all furnaces on a production scale, and this for decarburization with high-purity oxygen. Large-scale production operations for either melt-down or decarburization hinge to a great extent on settling the questions of the most economical and efficient oxygen purity, elimination of the smoke nuisance, balancing of production gains against somewhat decreased refractory life, and integration of potential production increases obtained through oxygen use with other mill facilities.

DISCUSSION

PRESENTED BY

GEORGE V. SLOTTMAN, Technical Assistant to the Vice President, Air Reduction Sales Company, New York, New York

E. T. W. BAILEY, Combustion Engineer, Steel Company of Canada, Limited, Hamilton, Ontario, Canada

A. G. ROBIETTE, Director, John Miles and Partners, London, England

George V. Slottman: It seems that we have made a complete cycle in combustion work. The first experimental work in this development, as I remember at the Steel Company of Canada in 1946, used oxygen supplied through a small pipe located below the oil line, and was in effect a high-velocity jet. Then there was quite a period when all of us were using concentric oxygen jets of various velocities surrounding the oil line. Finally, we appear from the paper to have come back to the proposition of using oxygen underneath the oil stream which completes the cycle.

From an engineering point of view, there is one problem which arises when using a very high-velocity jet, and that is the high oxygen pressure required to force the oxygen through the nozzle to obtain this very high velocity.

If there is no radical improvement obtained by the use of this high velocity, there is little point in it, since it brings with it the problem of compressing the oxygen up to 135-140 psi pressure. The energy that is required to compress oxygen up to 140 psi pressure is roughly a third of the energy that is required to make it, and there is thus quite a problem in compression when you use oxygen at these very high pressures.

At the moment, oxygen is being used for experimental purposes in combustion, but it is important to realize that this use is only experimental. Looking into the future, when oxygen is used in production for combustion work, it will be supplied undoubtedly from tonnage plants, and these tonnage plants will deliver oxygen at a fairly low pressure. The outlet pressure from the average tonnage plant is of the order of five to ten psi, which can be simply boosted to say 15 psi by a blower in order to force it through the pipelines.

I think we should give very serious study to the comparison of a high-velocity jet as against a low-velocity jet for this particular engineering reason.

E. T. Bailey: We, indeed, are indebted to Mr. Zimmerman for a very comprehensive summary and a seemingly fair appraisal of the various uses of oxygen in the open hearth furnace. To date, as he points out, there are three chief means of using the oxygen tool. The pessimists ruefully point out that there is little or no scrap upon which to use oxygen accelerated combustion, that we are getting back to the old puddlers fashions in the use of lances and/or jets to cut scrap or reduce carbon, that we are in the way, splash out roofs and walls, and paint the whole town red.

Notwithstanding the element of truth that applies to the above criticism, I am optimistic enough to believe there is a future for oxygen in the open hearth shop.

In comment I might say that at the Steel Company of Canada it was found possible to increase the air flow through the checkers when using oxygen accelerated combustion. This allowed the fuel rates to be substantially augmented. As an example a test carried out on an all basic, 180-ton furnace, had the fuel input stepped up to 700 gpm with primary oxygen input at 60,000 cfhr. Helicoidal inserts were used to diverge the flames. Charging time, which would normally extend over a four hour period, was reduced to 1¼ hours. Toward the end of the melt-down period, roof temperatures were allowed to reach 3200 F.

The most economical flow of oxygen and fuel for accelerating combustion will have to be determined for each furnace. Maximum, and it is hoped the most economical rates, will be those which will tax the capacity of the facilities provided to remove the products of combustion which can be produced in the furnace. Now, the limit is the amount of fuel that can be burnt in the furnace without having flames extend into the downtakes and checkers. In some cases this fuel increase can amount to nearly 100 per cent above normal fuel input rates.

A. G. E. Robiette: I thought you would like to hear about what we have been doing in England in regard to the use of oxygen, as very little has been published. We started during the late war years, but facilities were very poor at that time, and actual pilot-scale experiments started in about 1945.

We considered the various uses to which oxygen could be put in steelmaking, and we rejected the idea of using it as an adjunct to the open hearth furnace. We thought if you could take advantage of the conditions brought about by the use of oxygen, you could convert your pig iron into steel without the use of any fuel whatsoever, and our experiments have been directed on those lines.

We have produced heats on a small scale which have enabled us to produce two to three tons in a period of about twenty-five to thirty minutes, blowing with 90 per cent oxygen and nitrogen mixtures. We have done it in electric furnaces, and we have done it in specially designed vessels, and, by that means, it is possible to add progressively to the heat up to 30 to 33 per cent of the scrap. In other words, you could design a plant, an integrated steel works, which would absorb all of the circulating scrap without any other steelmaking process.

The contents of nitrogen has been about half of that found in open hearth practice — around about 0.002 per cent nitrogen — and the advantage is that you can treat any composition of pig iron irrespective of the content of heat forming elements such as Si and P. We have produced heats of steel from straight carbon iron made synthetically just to prove that this could be done.

We have developed a method of blowing, which does not employ any lances whatsoever. It is blowing with jets spaced from the surface, and there are two production size plants going up in Sweden for using this process, as well as one in France and one in England.

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1948 AISE ANNUAL CONVENTION AND
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CLEVELAND PUBLIC AUDITORIUM
Cleveland, Ohio

September 28, 29, 30 and October 1, 1948

IMPROVED D-C GENERATORS FOR REVERSING MILLS

. . . . laminated steel generator frames, instead of the usual solid design, will give better operation of reversing mill d-c generators during transient load changes . . . .

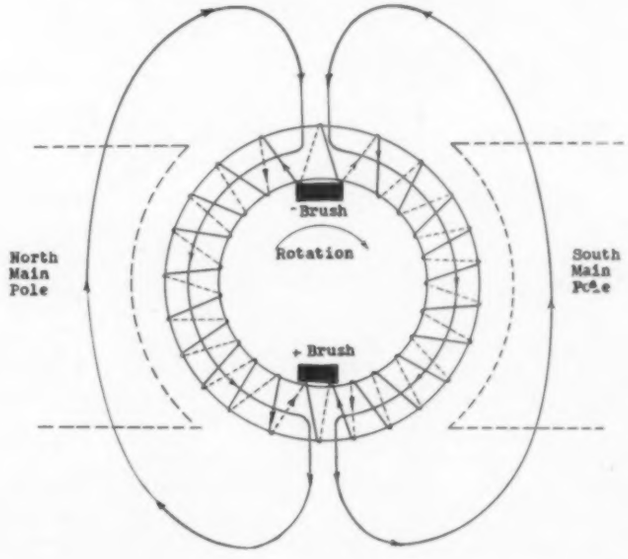
By C. LYNN, Manager
D-C Engineering Department
Westinghouse Electric Corporation
East Pittsburgh, Pennsylvania
and W. H. BURR, Electrical Superintendent
Lukens Steel Company
Coatesville, Pennsylvania

▲ DIRECT current generators for flywheel reversing mill mg (motor-generator) sets are, in general, subjected to extremely severe duty, insofar as commutation is concerned. The reversing mill motors, which these generators drive, of course, carry the same armature current as the generators; but the rotational speed of operation of the reversing motors is always much slower than that of the generators, thus imposing less severe duty from the standpoint of commutation. It is always desirable to have these generators operate at the highest practical rotational speeds, in order to make the flywheel as light as possible and to secure smaller and cheaper equipment. It is a fundamental of direct current rotating machinery, that insofar as commutation is concerned, everything else being equal, the product of kilowatts and rpm is a constant. In other words, from the standpoint of reactance voltage of commutation, it is just as difficult to build a 3000 kw d-c generator at 360 rpm as it is a 300 kw generator at 3600 rpm. This, of course, does not take into consideration the mechanical dissimilarities in the design, due to the differences in speeds.

These reversing steel mill generators are subjected to as much as 2¼ times rated load current peaks repeatedly during rolling operations. Not only must these generators supply power to drive the reversing mill motors in the actual rolling of the steel, but they must also handle the additional energy for accelerating and decelerating at the beginning and end of each pass. During the periods when the reversing motor is changing its direction of rotation at the end of each pass, it becomes a generator when decelerating and feeds power peaks back into the generators, which in turn become motors, using the power recovered from the deceleration of the reversing motor in restoring energy back in the flywheel. The ordinary circuit breaker setting for generators of this type is for 2¾ times rated current and occasionally the generators carry this or even greater current, causing the circuit breakers to open.

A very simple physical conception of the operation of a d-c machine from the standpoint of commutation, is to consider the armature of the machine as an electromagnet. As such, the magnetic poles of this electromagnet are midway between the main poles of the machine in space position. This corresponds to the points where the brushes are located. This can be understood very readily from Figure 1. The strength of the armature magnetic pole is proportional to the number of turns on the armature, that is, the number of armature conductors per pole, the current in the conductors, and the arrangement of the magnetic structure of the machine. These magnetic poles are essen-

Figure 1 — Shown here is a sketch of a simple two pole d-c generator armature showing field produced by load current in the armature winding.



Presented before AISE Annual Convention, Pittsburgh, Pennsylvania, Sept. 22, 1947.

tially constant in space position, irrespective of whether the armature is stationary or rotating.

In the commutating pole type of construction of a d-c machine, a pole with a commutating coil on it is located between the main poles, directly opposite in space position to the magnetic poles of the armature. The coils on these poles are connected in series with the armature, so that the current in them is always proportional to the current in the armature circuit. The number of turns on the commutating poles are made such that the mmf or ampere turns per pole of the commutating coil is made in the neighborhood of 125 per cent of that of the mmf or ampere turns per pole of the armature. Of this total, 75 or 80 per cent is used to overcome the mmf or ampere turns per pole produced by the current in the armature winding. The remaining 25 or 20 per cent of the mmf or ampere turns

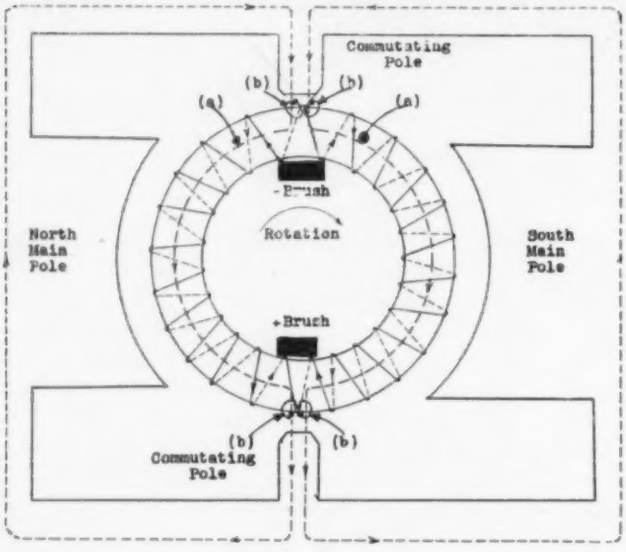


Figure 2 — In this simple two pole d-c generator the armature field (shown dotted) has been nullified by equivalent commutating pole MMF. The interpolar armature slot flux field is shown solid under the two commutating poles.

of the commutating coil, is used for sending a flux through the frame and commutating pole and across the reluctance of the commutating pole air gap and into the armature, midway between the main poles, for overcoming the field set up by the armature coils being commutated. This can be understood by referring to Figure 2. In this case, the field (shown dotted) which was originally set up by the total armature ampere turns per pole no longer exists in the commutating pole machine since the mmf or ampere turns producing this field has been essentially nullified by the major portion (the 75 to 80 per cent) value of the commutating coil mmf or ampere turns per pole. There is, however, a flux remaining which is set up in the interpolar space by the conductors of the coils being commutated. This is shown by the solid lines. This flux does not interlink the commutating pole coil windings, but exists in the armature teeth, and air gap; and, in the commutating pole machine, produces "a reactance voltage of commutation" which can cause sparking. In the non-commutating pole machine, the entire armature field, as shown in Figure 1, produces this "reactance voltage" of commutation, since it is not compensated by the mmf or ampere turns of the commutating field coil. It is, therefore, a much larger reactance voltage of commutation than in the equivalent size, rating and speed of a commutating pole type d-c machine. For this reason non-commutating pole machines can only be built in small sizes and at low speeds. The armature coils that are being commutated, that is, short circuited by the brush, cut this resultant field in the interpolar space. These coils, therefore, have generated in them a voltage, which voltage is short circuited by the brush. This is the "reactance voltage of commutation" and is the voltage that causes sparking when the resultant current that flows in the short circuited coils becomes relatively high. For a given reactance voltage of commutation, this current is limited by the resistance of the armature coil circuit itself, the resistance of the brush material, and the resistance of the contact of the brushes on the commutator. The magnitude of the reactance voltage itself, depends upon the size of the generator, the proportions of the armature slots, the arrangement of the conductors, the current loading of the coils and the speed of the machine.

The compensated wound commutating pole d-c generators are simply commutating pole d-c machines in which some of the turns on the commutating poles have been spread out and placed in slots in the pole faces of the main poles. The number of actual turns remaining on the commutating pole proper is reduced by the number of turns of the compensating winding that have been placed in slots in the pole face. The compensating windings are thus concentric about the center of the commutating pole. This compensating type of construction is used for two reasons: (1) to eliminate distortion of the main field flux by nullifying the armature field at the space position where the armature mmf or ampere turns actually exist and (2), to increase the overload commutating capacity of a d-c machine by reducing the commutating pole leakage flux. All the turns on the commutating field coil and all of the turns of the compensating field winding produce "useful" commutating pole flux, that is, flux that passes from the commutating pole tip into the armature. However, only the actual turns on the commutating pole itself produce leakage flux, that flows from the commutating pole to the main pole or frame. Thus, the fewer the turns on the commutating pole itself, the lower will be the value of leakage flux. This leakage flux, since it does not cross the commutating pole air gap, serves no useful purpose and does not assist commutation, but is detrimental in saturating the commutating pole, especially during times of high peak loads.

Since the commutating pole winding is connected in series with the armature circuit through the brushes, the field produced at the tip of the commutating pole is made to be in opposition and is proportional to the armature field until saturation of the magnetic circuit is reached, which can occur at extremely high overloads. To overcome saturation at high load currents as much as possible, larger than normal and tapered commutating poles are used in reversing mill d-c generators and motors. The tips of the commutating poles are shaped to give a field form to the flux that is sent across the reluctance of the commutating pole air gap, to

match as nearly as possible the field that is considered as being set up in the interpolar space by the coils being commutated in the armature. Since a finite number of commutating bars are used, and since the brush covers a definite number of commutating bars, generally in the neighborhood of 1½ to 5, this armature field is ragged and stepped and varies in position and magnitude with time, depending upon the number of commutator bars that are being short circuited by the brush, and with the intimacy of contact of the brushes on the commutator.

For machines that carry steady loads, the commutation problem is relatively simple. It is only necessary to make the design such that with the best shape of commutating pole tip and with the correct commutating pole air gap, the resultant reactance voltage short circuited by the brush is held to a minimum. The brush, therefore, has to take care of only that current that results from inability to have the armature and commutating pole field forms completely nullify each other. While the percentage of nullification can practically be made the same for any size machine, the actual resultant voltage will be greater, the larger the machine and the higher the speed. Thus, it is now easy to see, since brushes will only handle a given magnitude of circulating current without sparking, why the speed of the machine must be reduced as the kw capacity is increased, if objectional sparking is not to be obtained.

Direct current machines that have varying load currents, such as reversing steel mill generators, must have the so-called commutating pole flux in phase opposition, at any instant to the armature field flux in order to obtain as satisfactory commutation for any given load current, as when carrying the same load current under steady state conditions. The magnetic circuit of the armature of a d-c machine is laminated and must be so made, because the flux in it is alternating at a frequency proportional to the number of poles on the machine and the speed of rotation. Alternating voltages are generated, and alternating currents flow in the armature winding of a d-c machine. Direct current is only produced after a rectification of these alternating currents by the process of commutation. Under steady state conditions, the flux carried by the commutating poles and the stator or frame of the d-c machine, is constant in value and in magnitude, depending upon the load being carried. During changing loads on the d-c machine, this flux must change, since the current which produces this flux also changes in the commutating field winding, which current is the same as the armature current at any instant.

Whenever flux changes, voltages are produced. When the flux changes in the magnetic circuit of a d-c machine, the voltages so induced cause currents, called eddy currents, to flow in the magnetic structure. These eddy currents may be considered as exciting currents which are mmf or ampere turns that oppose the change in the flux which created them, irrespective of whether the flux is increasing or decreasing. The magnitude of these eddy currents which flow in a given size magnetic structure and for a given rate of change of flux, depend on the electrical resistance of the magnetic material. The higher the electrical resistance of the material, the less will be the opposition eddy currents and the more nearly will the flux change be in phase with the current change which produced the flux. Oscillograph tests have been made to show the relative speeds of flux changes in magnetic structures. If a value of one is assigned as a relative speed of flux change in a solid rolled steel frame, as used in a conventional constructed d-c machine, then the following values apply for different thickness of laminations for a laminated type of structure.

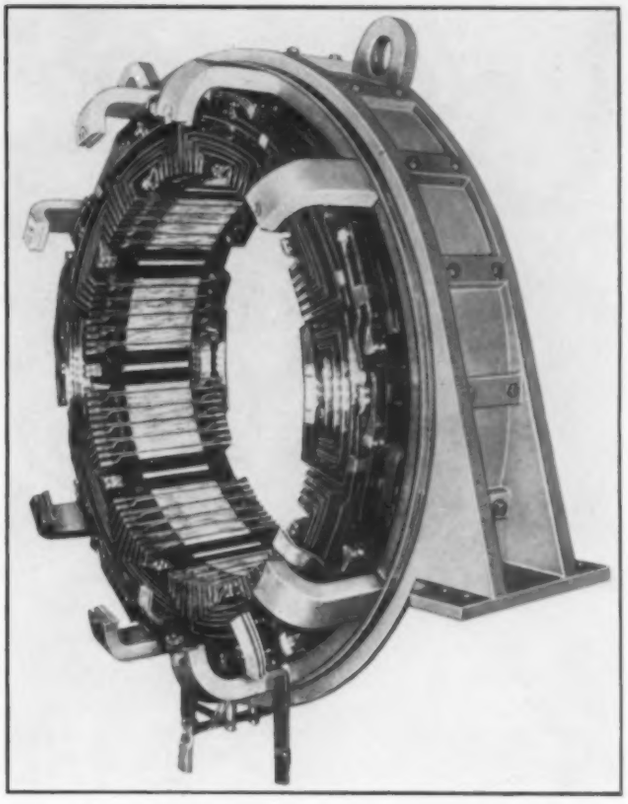


Figure 3 — The reversing steel mill generator stator shown has a laminated frame.

Material	*Relative speeds*
Solid steel	1
½ in. thick laminations	25 to 50
¼ in. thick laminations	200 to 250
0.0172 in. thick laminations	above 50,000

These are ideal figures, with definite insulation between each lamination and no structural obstructions such as clamping bolts, welds, etc., which would reduce these values materially in an actual frame structure, by short circuiting the laminations.

This effect has, of course, been known for many, many years, and the main poles on d-c machines are laminated even on those that carry constant loads continuously. This is done to reduce losses in the pole faces caused by "tufting" of the flux in the air gap as the slots and teeth of the rotor pass under the pole faces. All manufacturers have at times used laminated commutating poles on large machines that have rapidly changing loads. This was a step in the right direction but was not far enough. Completely laminated frames have been built in the past, mostly, however, on machines that needed laminated frames to permit extremely high rates of changes of main field flux to permit rapid changes in the values of the generated voltage, since the same principle applies to changes of flux whether

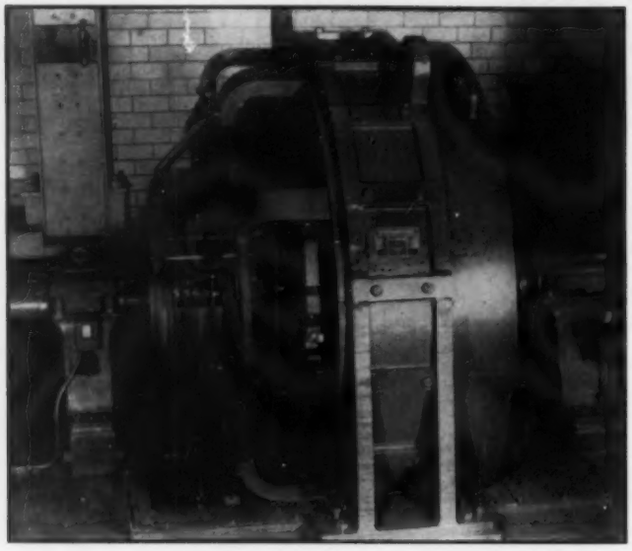


Figure 4 — The 2000 kw laminated frame reversing mill d-c generator of Figure 3 is here shown installed.

it is change of main pole flux or commutating pole flux. A few laminated frame generators have been built in the past in which too thick laminations have been used to take advantage provided by a laminated type of structure. An actual resultant relative speed of 25 to 100 will give wonderful improvements in transient load commutation on large size d-c machines.

It should be noted that in the case of commutating pole d-c machines, no appreciable flux is set up by the mmf or ampere turns of all of the armature conductors per pole, since the effect of that mmf or ampere turns is nullified by approximately 75 to 80 per cent of the mmf or ampere turns of the commutating pole field winding. Also, during steady state conditions, the interpolar armature slot flux field set up by the coil or coils being commutated is balanced out, insofar as possible, by the field from the commutating pole as mentioned before. Thus, the brush has to take care of only that current which flows in the coils being commutated, due to the remaining resultant field.

When transient load conditions occur, the eddy currents in the solid frame structure hold back the flux produced by the resultant commutating pole ampere turns. This has no detrimental effects on the armature field flux (the flux shown dotted in Figure 2) since this has already been nullified by the major portion of the commutating coil field strength. However, the interpolar armature slot flux field, which exists only in the laminated structure of the armature and the air gap, changes practically in phase with the change of the armature load current being commutated. On the other hand, the opposing equivalent commutating pole flux (which under steady state load conditions practically nullifies this interpolar armature slot flux field) lags behind. The reason for this is that this field not only flows in the laminated armature structure, the commutating pole air gap, but also in the commutating pole and frame structure. Since the frame structure and sometimes the commutating pole itself is usually not laminated, strong eddy currents would be set up in these two parts of the magnetic structure, during transient load changes, which would hold back the commutating pole flux change. Thus, during these transient current load changes, a very large "reactance voltage of commutation" is generated in the coils being commutated. This relatively high voltage produces heavy sparking, shooting streamers, and sometimes even flashing at the brushes and commutators. This can even produce a "hiss" or "singing" noise at the instant this heavy sparking occurs.

Figure 3 is a photograph of a stator of a reversing steel mill generator built and put in service this year, employing a laminated type frame structure for the purpose of securing extremely good commutation under transient load conditions encountered in reversing steel mill service. Figure 4 is an installation picture of the machine that uses this frame. The good commutation resulting on this generator during heavy transient load condition is shown in Figure 5. This is a photograph of the commutation resulting from a normal high peak load during actual rolling of steel, using this equipment. Note that light sparking occurs only on part of the

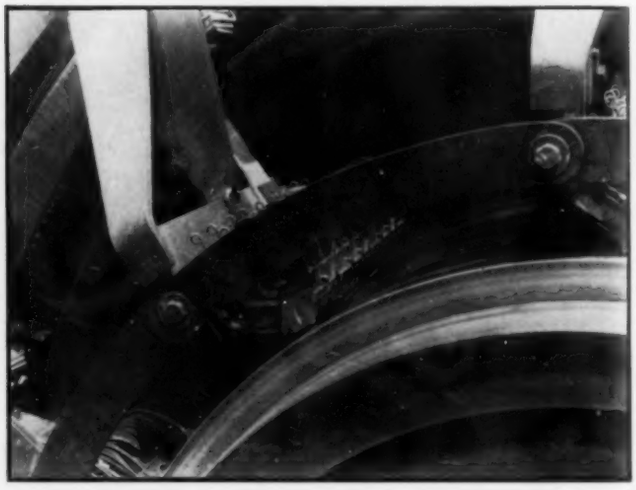


Figure 5 — Little sparking is noticed with the laminated frame generator even with high peak loads.

brushes, and note the complete absence of heavy sparking and streamers. The corresponding commutation on an older and equivalent large machine using a solid frame, with the same rate and percentage of load change, is shown in Figure 6. On this machine heavy sparking occurred during the peak load changes on all brushes and some streamers appeared, although the streamers did not record on the film of the photograph, apparently due to the shortness of their duration. There was even an audible "hiss" or "sing" occurring at the brushes at the instant the "spit" occurred. Even on this older solid frame generator, absolutely sparkless commutation was obtained at twice rated load when it was loaded back on another generator of the same rating.

The advantages of the laminated type frame generator in reversing mill service is apparent. Its use will not only give improved performance but reduce maintenance, not only on the commutator but also give longer brush life. On generators that are subjected to transient peak loads of infrequent occurrence, much less than that encountered in reversing mill generator service, the polishing action of the brushes on the commutator during the periods of steady or low loads, between peak load conditions, is generally sufficient to keep the

commutators polished and is effective in overcoming the burning of the commutator bars that occurred during peak load conditions. Thus, under such conditions, maintenance is held to an average value. On machines in such service, laminated frames are not justified.

On ordinary reversing steel mill generators, however, the peaks are so great and of such frequent occurrence that such smutting and burning of the commutator bars, which occurs during the sparking periods of transient loads, has in many cases resulted in more than normal maintenance. Reduction of maintenance will, of course, increase the availability factor of the generators. Improvements in commutation obtained by using laminated frames, should permit building of reversing mill generators at higher speeds while still obtaining improved commutating performance.

As mentioned before, it is not necessary to laminate the steel structure of the reversing mill motor because the product of kilowatts and rpm on these machines is much lower than on reversing mill generators. Furthermore, the commutator peripheral speed is very much slower, which simplifies brush riding. This means that the margin of commutation is greater on these machines and they, therefore, can stand the same rates of change of load current with less sparking than can generators.

During the war, there was installed on the main drive in the 120 in. plate mill finishing stand at Lukens Steel Company, a 7000 hp, d-c motor, 35 to 80 rpm. Supplying power to this unit is a 6000 kw motor-generator set consisting of a 6000 hp, 13,200 volt, 60 cycle slip ring induction motor, 505 rpm, driving three 2000 kw, 700 volt d-c generators, together with a plate steel flywheel weighing 100,000 lb. The load fluctuations on this motor, which in turn are reflected on the d-c generators, are very severe, frequently amounting to 250 per cent load, and in some cases have even reached 300 per cent of their normal rated capacity.

Figure 6 — Compare the sparking of this generator which is of solid frame construction with that of Figure 5. Generators are equivalent and photographs are taken with same rate and percentage of load change.

The commutation under such severe overloads, especially during the transient load changes, was not particularly good, and the cost of maintenance was relatively high. Burning on the edge of the commutator bars made it necessary to grind the commutators of the generators frequently. Brushes in some cases lasted only a short time and it was necessary to keep very close watch of the commutators and brushes.

In order to reduce this maintenance and to obtain improved performance under the high peak load conditions that exist on this mill, Lukens Steel Company installed a laminated frame on one generator of the set. Before placing the equipment back in service, the laminated frame generator was electrically loaded back on one of the other generators, both under steady state and transient load conditions, up to over 200 per cent load, and extremely good commutation was obtained under all loading conditions. In actual service, the faster voltage response of the laminated frame generator did not appreciably affect load division during the transient load changes, on account of the powerful paralleling effect of the differential series and cumulatively crossed series fields used on all generators. After two months in regular operation, the commutator on the laminated frame generator shows only slight discoloration with no "hiss" or "sing" when the load is applied suddenly. There is, however, some very slight sparking on some of the brushes when peaks of 200 per cent and more are encountered.

Based on the performance of the first laminated frame generator, laminated frames were ordered for the remaining two generators, and these laminated frames have already been delivered to the plant. The installation of these frames is quite simple and can be done over a week-end shutdown when operating conditions are such as to permit this. To install a laminated frame on an existing old generator, the following is carried out. The old solid frame with all poles and windings in place, is turned down on its side, supports being placed under the edges of the frame, at the sides of the poles and if necessary under the windings or connections. All main and commutating pole bolts are removed and the solid frame is taken away from the poles and windings, which remain resting on the blocks as a complete unit, being held together by the end connections of the commutating, compensating and series field windings. The new laminated frame is then lowered into position around the group of poles and windings, the pole bolts inserted and the poles drawn up tightly against the frame. At the same time the pole spacing is checked. The stator assembly with the new laminated frame is then reinstalled back on the mg set. The only new parts required in this type of changeover is the actual laminated frame structure itself. The laminated frame is made interchangeable with the old solid frame.

When this work is completed, Lukens Steel Company feels that even with these sudden overloads, maintenance costs of these generators will be less than normally experienced on generators with the old types of frames. This refinement in the design of d-c generators has improved the commutation on these machines and there is no doubt that advantage will be taken of this new development when designing generating equipment of this type in the future.

DISCUSSION

PRESENTED BY

H. W. BARTLING, Sales Engineer, Steel Mill Section, Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin

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I. C. SMITH, Chief Engineer, Crocker-Wheeler Electric Manufacturing Company, Ampere, New Jersey

C. LYNN, Manager, D-c Engineering Department, Westinghouse Electric Corporation, Pittsburgh, Pennsylvania

R. W. GRAHAM, Assistant General Manager, Bethlehem Steel Company, Sparrows Point, Baltimore, Maryland

W. H. BURR, Electrical Superintendent, Lukens Steel Company, Coatesville, Pennsylvania

H. W. Bartling: We certainly agree that it is desirable to provide interpole flux paths that are entirely laminated in order to greatly improve transient commutation, maintenance, and performance of d-c machines for heavy duty reversing mill service. The need for this improvement became apparent to us during the war when numerous installations using the new quick-reversing rotating control systems were made. To meet this need we built two 7000 hp motors and supporting generators incorporating this feature, and these have been operating with gratifying low-maintenance performance for the past several years.

There are two points we would like to discuss:

First, we believe that there is just as much or more advantage in applying this feature to the motor as to the generators. This contradicts the conclusion made in the paper that: "It is a fundamental of direct current rotating machinery, that insofar as commutation is concerned, everything else being equal, the product of kilowatts and rpm is constant." We believe this has no valid application to reversing mill motors and generators because everything else is far from being equal; in particular, the peripheral velocity of the generator is usually several times as great as that of the motor. The quoted "fundamental" is true only for machines with equal peripheral velocities.

It would appear to us that a far more fundamental principle is that kilowatts per inch of diameter is a constant for the highest permissible value of reactance volts. Examined on this basis, most mills will show (per commutator) almost as many kilowatts per inch of diameter for the motor as for the generator.

However, the generator commutation is hindered by high commutator speed, vibration, and low resistance armature coils. On the other hand, the motor is hindered by its speed range above base (which increases reactance voltage in direct proportion), and its reversing operation which allows no choice of brush position and tends to cause double seating of the brushes.

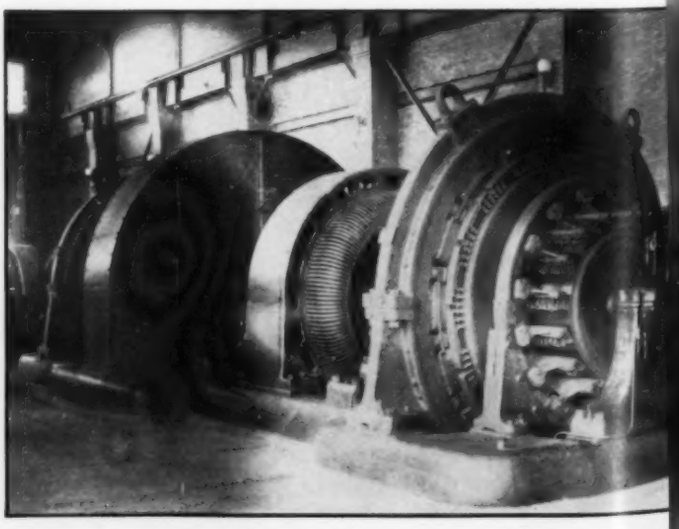
The generators tend to be designed for as high a kw per in. of diameter as commutation will permit, in order to allow the use of a high rpm. And the motor is designed to the same limit, in order to minimize the WR^2.

The relative severity of the reactance voltage between motor and generators will depend upon such factors as the number of generators in parallel, the motor speed range, and whether the motor has one or two commutators. In numerous instances the motor will have considerably higher reactance voltage at its top speed than the generators.

Second, we found it desirable to accomplish the laminated interpole path by means of a special laminated sub yoke, which abuts the top of the interpole and passes the interpole flux into the sides of the laminated main pole (as the top of a "T"). Together, these form a continuous magnetic path around the periphery of the machine (except for small air gaps). This construction permits the use of the standard rolled steel yoke, which still carries the main pole flux and all mechanical forces. This results in only a slight modification of standard construction, and is as easily applied to long cored motors as to the short cored generators. If the whole yoke of, say, a seven foot core length motor were to be laminated, an elaborate supporting structure would be required to support the weight and torque of these segmented laminations.

B. H. Caldwell: The authors have given a timely discussion backed by experimental data illustrating the advantages of properly laminating the magnetic circuit for the commutating pole flux for this type machine. In this connection the history of the development of magnet frame construction within our company is of interest. Prior to 1915, magnet frames were built using cast steel or cast iron construction. At about that time electrification of steel mill drives was under considera-

Figure 7 — This motor-generator set which was built more than twenty-five years ago had a laminated frame.



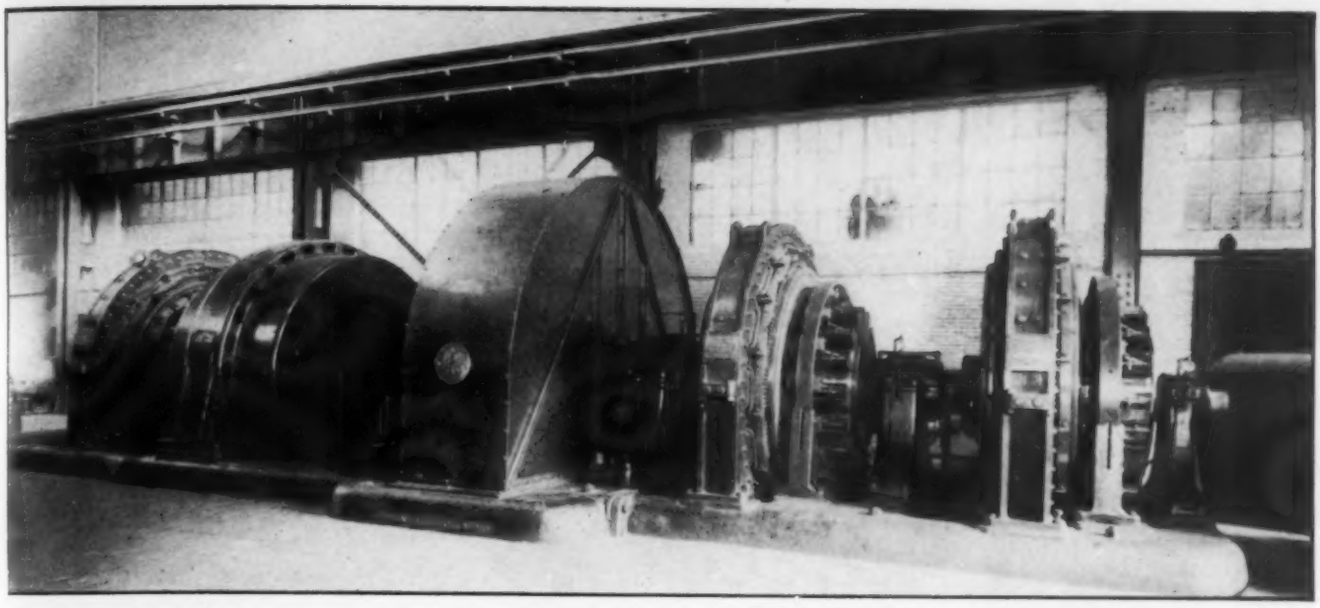


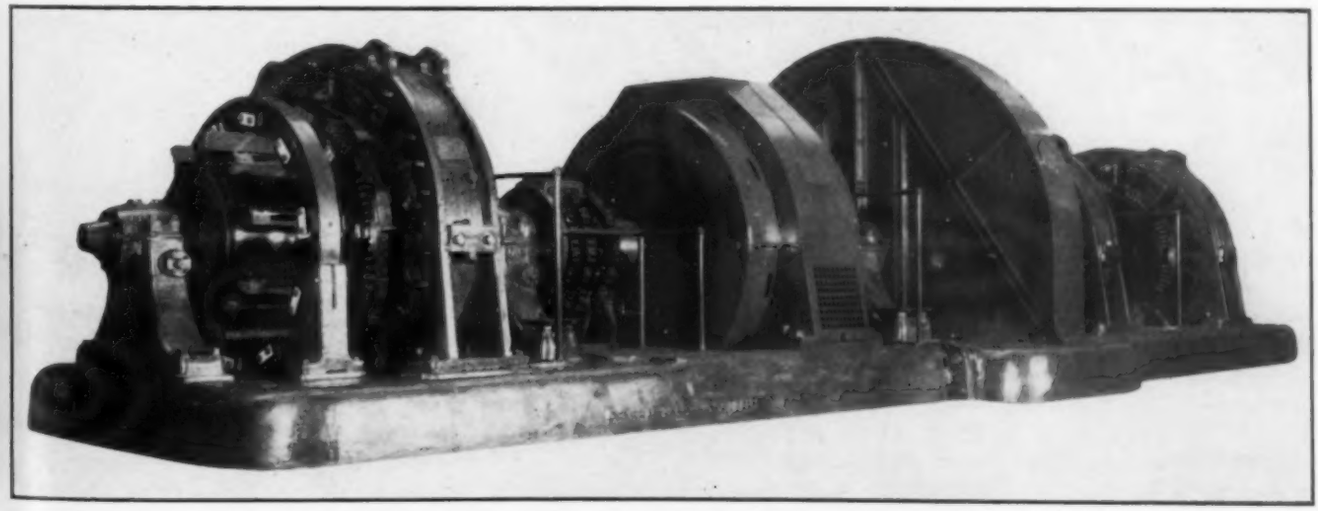
Figure 8 — Flywheel motor generator consists of three 16 pole-3000 kw, 375 rpm, 750 volt generators driven by an 8 pole, 5000 hp, 375 rpm, 6600 volt induction motor. The frame is made up of punchings bolted together with supporting side plates.

tion. Even at this early date the advantages of the laminated magnet frame were appreciated. Lacking data on the rates at which the current and voltage changes might occur, our engineers decided to take the conservative course and use laminated frames for reversing mill drives. Also the cast frames frequently had non-uniform sections due to hidden cavities, which adversely affected commutation. But this was a secondary consideration for making the change, and the primary one was to provide a laminated frame structure to favor rapidly changing flux. Generators were shipped during the year 1917, to Ashland Iron and Mining Company and to Keystone Steel and Wire Company. The construction used is illustrated in Figure 7, which shows a motor-generator set built for Otis Steel Company in 1922. The generators were rated 2700 kw, 375 rpm, 600 volts. The punchings were riveted together in bundles and bolted to the cast steel supporting ring. The punching thickness was 0.060 inch. Figure 8 illustrates a later type which was built for the Bethlehem Steel Company in 1927. The frame is made with ¼ inch punchings which are bolted together with supporting side plates. These generators were rated 3000 kw, 375 rpm, 750 volts. Another example of this same construction is shown in Figure 9, which is a photograph of a set shipped to Lukens Steel Company in 1926. The generators are rated 1050 kw, 600 rpm, 330 volts.

The technique for fabricating the frame from a solid steel plate or slab was developed within our company during the period following World War I, and was first introduced as our standard construction in 1925.

The desire to use this simpler construction for reversing mill generators initiated a more detailed study of the problem. By this time much field data had been accumulated which served as a basis for the study. It

Figure 9 — This mg set, which was built in 1926, also had generators with laminated frame construction.



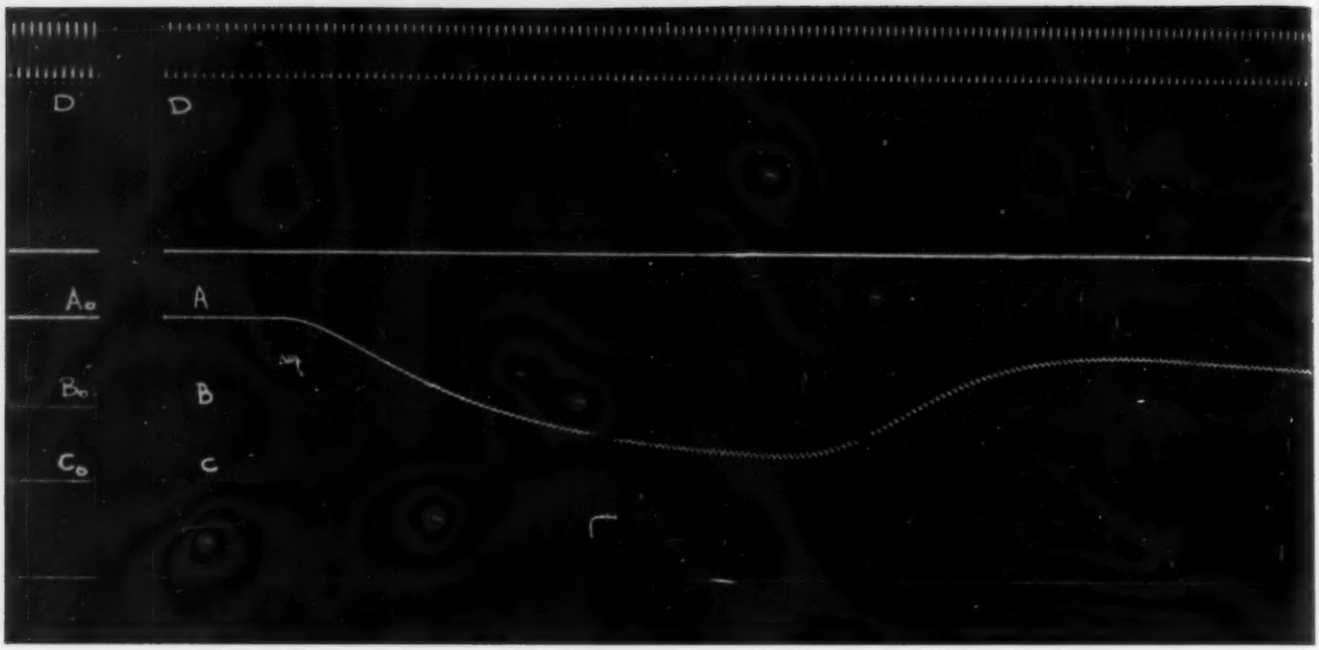


Figure 10 — Oscillogram shows voltage reversal test on main drive generators for slabbing mill. D is timing wave, A-A is field volts, B-B is field amperes, and C-C is line volts.

was concluded for reasons given later in this discussion that with proper design the solid steel frame could be used successfully. Subsequent use of this construction from 1927 to date substantiate this conclusion.

There are additional factors not mentioned in the paper which bear on this general problem and which should be considered in an attempt to get the overall picture. First, consider the concept of depth of penetration. A relation which has been derived from theoretical considerations and which has appeared on numerous occasions in technical literature is

$$\delta = \text{depth of penetration} = 0.10\sqrt{\frac{p \times 10^9}{f\,\mu}}$$

where p is resistivity in ohms per inch cube
f is frequency in cycles/sec
μ is permeability
δ is in inches

This means that the flux penetrates to an effective depth of δ inches, and that the solid steel slab is effective to that degree in carrying alternating flux. The induced or eddy currents in the solid slab which encompass and oppose the build-up of flux have a restricted return circuit for flux near the surface, hence this part of the material is just as effective as would be a comparable amount of material in a well-laminated structure.

Changes in armature current for typical applications correspond to rates which are approximated by an alternating current of some 2 to 3 cycles per second. Common magnet frame material has a resistivity of 7 micro-ohms per inch cube and a permeability of approximately 500 at a flux density of 100,000 line per square inch. For these conditions, the depth of penetration is 0.265 inch. In a typical design the magnetic section included in this surface layer of the stator frame, which effectively carries the rapidly changing flux, can be 20 square inches compared with 30 square inches in the body of the commutating pole. Now, if the ultimate safe load of the machine is limited by the flux capacity of the commutating pole body, it follows that for quick load changes the solid magnet would introduce a limitation corresponding to a maximum current somewhat lower than the limit set by the commutating pole body. Thus, it is apparent that the design of such a machine should take proper account of the transient flux capacity of the stator frame. This means keeping the commutating pole flux as low as possible which can be done by keeping the reactance voltage of commutation low, and by putting a high percentage of the commutating winding in pole face slots to reduce the interpolar leakage flux.

Figure 11 — Field current and line voltage of Figure 10 are here plotted to a larger scale.

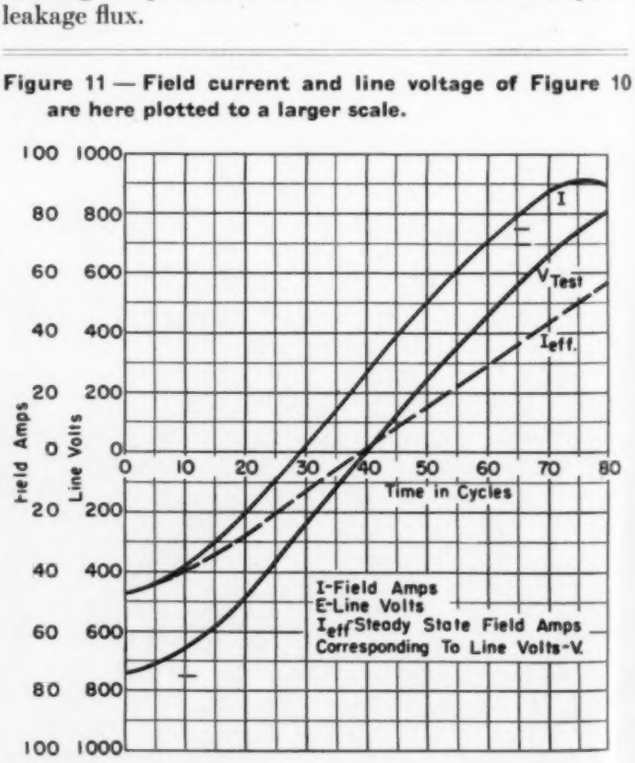


Figure 12 — Speed reversal test on main drive motor for slabbing mill, top speed to top speed (80 to 80 rpm).

Another factor of importance is to minimize the damping effect of the stator frame by making a so-called "high reluctance" pole. This involves making the air gap portion of the magnetic circuit a high percentage of the total. It is apparent that such a design is less affected by restricted frame area during transients, since the reluctance offered by the solid section is a smaller percentage of the total.

Thus far only flux changes in the commutating pole circuit have been discussed. Modern practice is to go to higher speeds of reversal which necessitates more rapid reversal of main pole flux. This reversing flux links the coils which are undergoing commutation and which are short-circuited by the brushes. These coils respond in the same manner as the short-circuited secondary of a transformer; that is, a voltage equal to the primary volts per turn is induced in the secondary to produce current in the short-circuit coil. This voltage can be of the order of 0.3 to 0.4 volts per turn, and with a brush overlap of 4 segments, a voltage of approximately 1.5 volts may be available to produce circulating current between the edges of the brush. Commutation is disturbed and sparking results. Note that this disturbance appears independent of whether or not the stator frame is laminated.

The oscillogram of Figure 10 illustrates some of these points. This data was taken on some 2250 kw, 514 rpm generators which provide power for a slabbing mill. For easier reference the curves of field current I, and line voltage V, are plotted in Figure 11. In addition a curve of effective field current I_{eff} is plotted. The values of I_{eff} are determined from the saturation curve as the field current required to produce the line voltage V during steady-state operation. Then the difference between I and I_{eff} is a measure of the excitation resulting from eddy currents in the stator frame and in the pole rivets. With a perfectly laminated structure, I and I_{eff} would be duplicate curves. Note that at the start of the reversal, the divergence of I_{eff} and I remains small. It is during this period that the surface layer of the solid frame is being used. As time progresses, the surface layer saturates and the divergence of the two curves increases.

The time of reversal is approximately 1¼ seconds, compared with the standard guarantee of 2 seconds. Note that the field current actually rises to 1.8 times its final steady-state value. At this point, approximately half of the shunt field excitation is used up in opposing the excitation due to eddy currents. This illustrates the very effective control job done in quickly applying a forcing voltage to the field, and then reducing the excitation to its proper value when the generator voltage reaches normal. Figure 12 illustrates the final adjustment.

The adjustment shown in Figure 10, was preliminary, and illustrates the tendency of such applications to overshoot in voltage. This tendency is always present in such a system independent of whether or not a laminated frame is used. Figure 12, which shows line voltage, current and speed during reversal of two 5000 hp motors used on a twin drive blooming mill, illustrates the excellent job which can be done in getting high speed of reversal without overshoot. The build-up of line current in this case can be approximated as ¼ of a wave of alternating current of ¾ cycles/sec. Note that the high rate of change of main field flux and line voltage occur at the same time as the high rate of change of line current. Thus the transformer voltage appears at a time when the commutating field flux is varying from its steady-state value, which is a bad condition.

The oscillogram of Figure 13, shows line voltage and current for the same motor during actual rolling. The rate of rise of current is somewhat higher than for straight reversal, and can be approximated by ¼ of a wave of alternating current of 2 cycles/sec. This and similar data form the basis for assumptions made earlier in the discussion.

Another source of difficulty which requires diligent attention is hysteresis in the frame and pole material. With frequently reversing load and line voltage, it is apparent that any appreciable hysteresis in the mag-

Figure 13 — Load test during rolling for main drive motor of slabbing mill. Top curve is line current and bottom curve is line volts.

netic circuit will upset the commutation adjustment and cause poor commutation. This phenomena can occur with either solid or laminated construction, since it is a function of the composition and the method of fabricating the steel.

We have attempted to broaden the analysis presented in the paper so that all factors can be properly evaluated. Laminated stator frames for d-c generators for reversing mill service have been in use for more than 30 years. By proper use of design principles, it has been proven possible to use a rolled-steel stator frame successfully; thus permitting a simpler construction which is better adapted to modern construction methods. Machines built by us have been carefully designed to suit the operating conditions, and it is anticipated that only in rare cases will a marked improvement result with the substitution of a laminated for a solid frame. Certainly each case should be studied, and a decision made only after a careful review of all pertinent design factors and operating conditions.

New applications of this type appear to involve higher speeds of reversal, lower inertia motors, and higher rate of increase of load current. For some applications these factors may combine to make a return to the laminated frame more attractive. For instance, this construction was proposed by us in 1943 on a proposition for a blooming mill drive. However, it is most important that all pertinent design factors be properly controlled to insure a well balanced design.

G. E. Stoltz: I would like to add to the history of laminated frame generators used for reversing blooming mill equipment. I believe the first blooming mill equipment installed with laminated generators was in 1912 — it might have been in 1913 — at the Steel Company of Canada. We furnished that equipment, and we found the type of machines used depended to a large extent on the type of control installed.

Laminated generators could be used with the control we have today with satisfactory results, but with the control available at that time, might not have performed as well as desired.

Also there is a lot of difference in the amount of WR^2 in a motor today compared to what was used in those early days, and if you study some of the early motor equipment you will find that the apparatus, while it took into consideration what a reversing mill is required to do, still was not too far from the engine-type generators that were used in those days. The flywheel effect per horsepower was very much larger than it is today.

With this early installation of laminated generators, we found that one of the problems was to prevent the operator from reversing too fast. The flux in the laminated fields would change very fast, and considerable armature current would be required to cause the motor armatures to follow. The commutating problem became that of commutating these high reversing peaks instead of the load peaks.

Later on when Mr. Caldwell's company came into this field, I know they built laminated frame generators, and I think they recognized the same problem because some of their units, maybe all, had a follow up type of master switch driven by a motor. The operator could reverse a handle quickly, but the master switch was driven by a motor which could be set to change the actual voltage in the field of the generators at whatever rate the manufacturer chose.

I. C. Smith: I think the comments so far all essentially agree on the need for measures of this sort in conditions of this kind. I would agree also that the best way to correct conditions of this sort is at the source, that is go right back into the magnetic circuit of the interpoles and make that as suitable as possible for rapidly changing flux. However, it has been found that the use of highly inductive shunts on the interpole circuit may accomplish sufficiently satisfactory results when it is not expedient to change the design of a machine which is already installed.

One case I have in mind was where the rate of regenerative current growth in the motor was excessively high due to the fact that the reversing motor was required to decelerate in one second, whereas six seconds were allowed for it to accelerate. Obviously, that was an undesirable adjustment of the control. Nevertheless, it existed and it was expedient to avoid readjustment if possible.

The interpole air gaps of the motor were shortened as much as possible. An adjustable resistance was connected in parallel with the interpole and compensating winding, a very highly inductive shunt was constructed, and by proper manipulation of the air gaps in the shunt, it was possible to get this rapid reversal with black commutation, even under field weakened condition of the motor, whereas previous to doing this, the commutation was so bad that at times the motor did flash over between brush arms and the operation of the motor under those conditions was considered impractical.

C. Lynn: I would like to thank Mr. Bartling and Mr. Caldwell for the engineering information which they have added to this subject this morning. I do not propose to go into a design discussion, because I do not think this is the place for it. However, I would like to take just one second and comment on one of Mr. Bartling's statements.

If you will just look at the machines in your own plant, you will see how the problem of kilowatt and rpm applies by noticing the reduction of speeds as the size of the machines increases in kilowatt or horsepower. That is a fundamental with which neither Mr. Bartling nor myself had anything to do. The sub-laminated structure has been used, particularly by English designers, as a compromise, and is better than a solid frame, but is not as good as a completely laminated frame.

We have, of course, been familiar with the laminated frame, as Mr. Stoltz told you, since 1912. We have also seen some of the laminated frames built by competitors on steel mill generating equipment, which bear out the statement that I made in my paper, that most of them had too thick laminations. Mr. Caldwell in his discussion said one had 0.060; two others had 0.250 in. We think that is much too thick.

We, too, have produced a lot of oscillograms which I could have shown you here. I chose, however, to use two pictures to bring you the gist and the heart of my paper, and those were the last two pictures which showed the commutation on the generator before and after the change to a laminated frame.

R. W. Graham: Commutation has always been a difficult problem on high peripheral speeds of commutators on large generators. Design engineers have tried devious ways to improve it. They are continually fighting a law that resists changes in flux in magnetic materials. We have 3000 kw generators in our plant, built in 1920, where the generator magnet frames were made from steel punchings riveted together and supported by a cast steel frame.

We have 3000 kw generators, built in 1927, with magnet frames of rolled steel construction. The pole pieces were laminated and bolted to the rolled steel magnet frame.

With rapid deceleration and acceleration rates required of mill motors today, design engineers have been forced to take advantage of every means to provide rapidly changes in flux decay and build-up. With the new rototrol, amplidyne and regulex controls, field fluxes must respond rapidly and proportionally to changes required in controls.

With the old cast steel frames (not always homogeneous) it was impossible to collapse the field and reverse it in short-time required. Double voltage or field forcing was resorted to.

The laminated field structure will materially aid the quick reverses of flux and assist the new methods of controls used.

The same reasoning can be applied to help overcome the reactance voltage of commutation. Laminated brushes or double brushes in same holder will keep down this voltage. The double brushholder with brushes at two different angles has been tried but we do not like it.

The author mentioned that it was necessary to grind generator commutators frequently, and brushes were short-lived. What does he consider should be the life of brushes on generators, and just how often did you grind the commutator, once a year or oftener?

There is one point in design of generators, as well as reversing motors, that has given us considerable trouble, that is the interpole and compensated pole winding are divided in two parallel circuits. The resistance of these windings are so low that a slight unbalance diverts the entire load on one-half of machine resulting in an overroasting of the other section. This is especially true on fully enclosed forced ventilation machines where damage is done before it is discovered.

The many circuits of heavy pole face winding, interpole winding, and series field winding are becoming so intricate and congested that it is almost impossible to get in and clean the insulated sections of these conductors, and we have failures due to creeping grounds from conductor to frame. This is true of older installations where mills were not laid out to clean and ventilate the cooling air. In our modern machines, material has been worked to the limit and layout of conductors are too congested for bare copper connections.

C. Lynn: Mr. Graham's question on commutator surface conditions and brushes is one that cannot be answered with a definite statement. Designers of rotating machinery realize the many variables under which d-c machines have to operate and provide wearing depth in the commutator to take care of these conditions. Some plants may have atmospheric conditions that are very detrimental to commutator surfaces and brushes. Others may have mill dust present. Still others may subject the machines to continuous overloads, while in still others some motors may be operated at such light load, that a glaze forms on the commutator which can result in brush chatter. As a rule, industry does not consider abnormal maintenance if commutators are ground at intervals of a year. Sometimes machines will run 5 or 10 years without grinding. In other cases, grindings may have to be done more often or commutators may have to be hand stoned at intervals of a few weeks or the surface polished with canvas weekly.

Similarly, brush life is a great variable and the same factors that apply to commutator surface conditions also affect the life of brushes. Brushes themselves not only vary between manufacturers, but vary even between the same set. In normal industrial service, a set of brushes should last a year or longer. In steel mill service, where machines are operated sometimes over a 90 per cent time factor in a year, the brush life may be as much as half of this or less. The machine manufacturer cannot always supply with the machine the best brushes for the particular machine, because the brushes that work best on his test floor may not work as satisfactorily as some other grade under the service conditions to which he subjects the machine.

Regarding the point of parallel circuits in commutating and compensating windings, note that in most cases soldered connections are used, particularly on large sized motors such as used in continuous and reversing steel mill service, and usually such untoward results do not occur. There is nothing fundamentally wrong, electrically or magnetically in using parallel circuits. This is the best way the designers have in

(*Please turn to page 70*)

Cleaning of Service Water

IN STEEL PLANTS

. . . . the self-cleaning water strainer described in this article has many potential applications for steel mill use . . . .

By S. P. KINNEY

S. P. Kinney Engineers, Inc.

Pittsburgh, Pennsylvania

▲ EVERY operator knows the importance of keeping general plant and mill water clean. It is imperative that high pressure descaling water be free enough from dirt and foreign matter to keep the spray nozzles open. It is also important that the lines to the spray nozzles be kept free of dirt and material which will build up and plug the lines.

The work of keeping the service water clean for steel plants has in the past been accomplished by using traveling screens, or an ordinary bar screen at the river intake. This intake screen is generally followed by some type of basket screen, or possibly an automatic screen, or strainer, generally installed at point of use, that is, right at the mill. This design accomplishes its purpose when the river is low and the water is fairly clean. When the fall storms and the spring floods appear, the system quickly becomes overloaded with foreign material. The bar and the traveling screens at the inlet become burdened with foreign material and the necessity of rapidly changing the basket screens at each mill unit soon becomes apparent. The need for properly proportioned and suitably chosen strainer units is obvious.

Plant design — It would be very desirable, but extremely difficult, to clean water from a highly polluted stream or a lake to a fine degree of cleanliness in one step. As indicated above, bar screens are generally used on the intake at the river. If these screens are made large, they will take care of the river floods and the high water resulting from storms. If they are too small, they become plugged and the water supply to the plant suffers.

In most plants the rotary screens at the river are well designed and proportioned and do a very good job. It is the next step in the straining process which needs attention. We would all like to take a screen of 100 or 200 mesh, put it on a line and leave it alone. Theoretically, this would be fine but practically it is difficult to keep such a screen clean and free from dirt when taking water from the rivers, or lakes, that are generally encountered in industrial districts. It is obvious that the straining or the cleaning of the water must be done in steps. First, we put in a traveling screen with a coarse mesh and this should be followed by an automatic strainer with a fairly coarse mesh. This strainer cannot be expected to clean the water down to a high degree of cleanliness in the one step, therefore, a coarser mesh at this point to rough out the larger particles in the water, is most desirable.

Central cleaning station — One way to get rid of trouble is to eliminate it at the source. Therefore in most large plants, it is desirable to install a central cleaning station to take out the greater part of the dirt before it ever enters any of the mill lines or spray systems.

Many plants are now installing a river intake with adequate rotary screens followed by self-cleaning strainers large enough to take the entire mill supply. This water is partially cleaned in this battery of strainers. The straining media used is amply small enough to take care of the water for all ordinary purposes. There should be no building in their lines after these strainers, and the water should be clean enough in many cases for use in coarse sprays. Where finer cleaning is required, it is a practice to install a strainer at each unit. This strainer is large enough to take care of the particular use and can be equipped with straining media which is fine enough to clean the water for the system which follows.

In the Pittsburgh district, there are a number of such installations where all of the mill water is treated, first, by a traveling screen at the river, second, by a battery of large strainers following the traveling screens, and third, by smaller strainers equipped with finer straining media at individual units where cleaner water is required. The central station at the river, is cleaning as high as 200,000 gallons a minute through a 1/16 or 1/8 in. orifice. The strainers following in each individual installation may be cleaning 4000 or 5000 or 6000 gallons

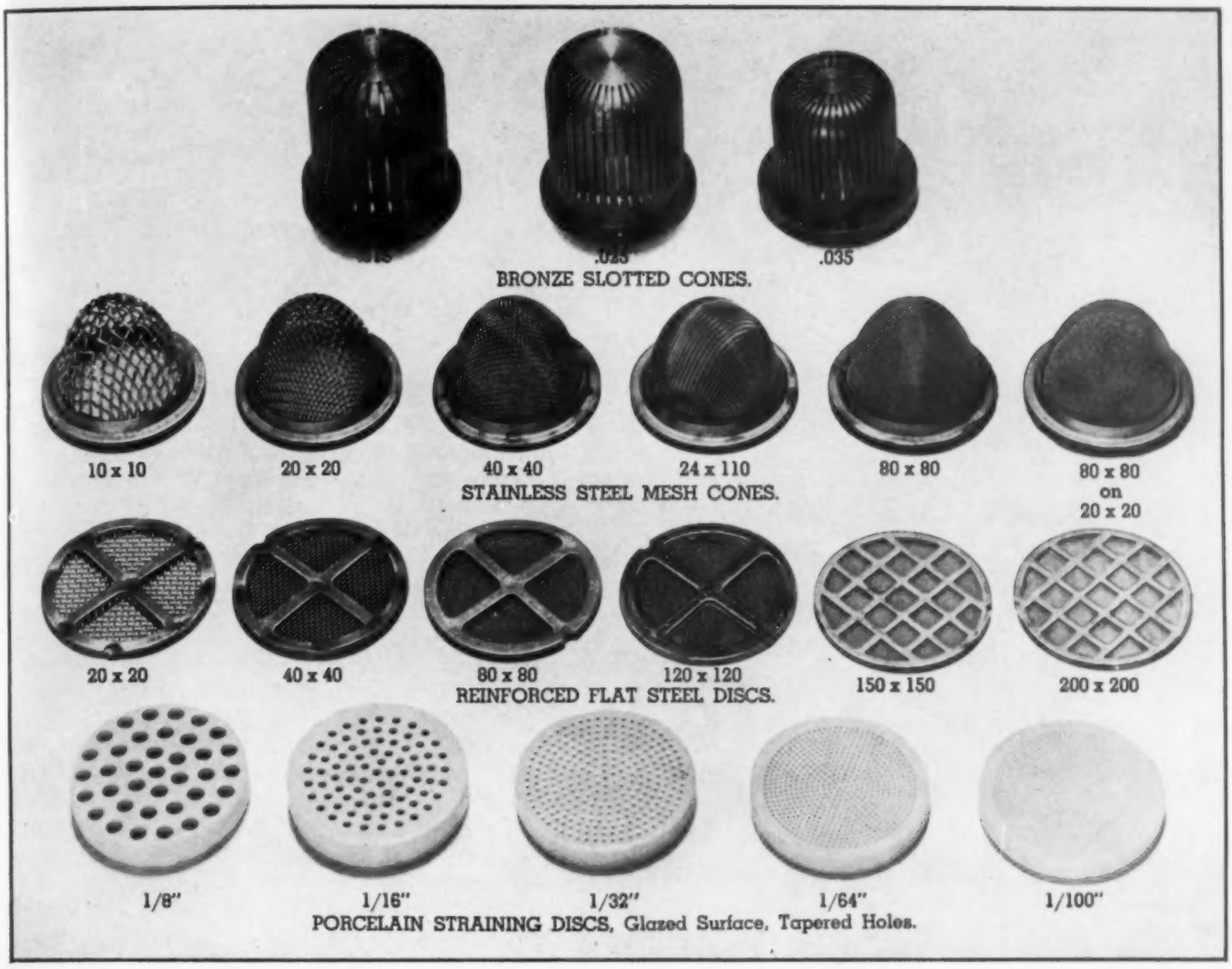


Figure 1 — The straining media consist of bronze slotted cones, stainless steel cones, flat stainless steel reinforced discs, and glazed porcelain discs with tapered holes.

per minute to a fineness equivalent to a $\frac{1}{32}$ in. opening, or smaller.

Adaptability of water to straining — The degree of straining which may be accomplished with any given water may be different from another water. For instance, a still mountain lake which is standing almost dormant and which has very little foreign material in it, might be easily cleaned with a straining element which was equipped with 200 mesh openings. This cleaning probably could be done with one pass through a strainer. A river at flood stages such as is experienced in the Pittsburgh district in the spring of the year, might need a great many steps in the cleaning process before we could apply even a $\frac{1}{64}$ in. opening to the water.

It is therefore obvious that all waters may not be treated with the same straining media, and that the selection of the straining media for any given application may be difficult, and in some cases may result in trial and error.

New straining media — Recently, there have been some new types of straining media made available for straining water. This new strainer has been in operation on very bad river water for sufficient time to establish the fact that it will keep clean under difficult conditions.

In the top row of Figure 1 will be seen a number of cones containing slots. The slots in these cones provide a large free area and therefore a slow velocity through the straining media. The slots may be obtained in various widths according to the amount of foreign material in the water and the location of the strainer in the mill system. The slots in the strainer cone on the left are 0.015 in. wide, the next cone has a slot width of 0.025 in. and the third cone has a width of 0.035 in.

In the selection of straining media for bad river water, the cone with 0.015 in. wide slots is generally selected for the strainer in the central station which is placed immediately after the traveling screen.

The slots in the cones provide a large free area and are of especial use where fiber is encountered in the water. The probability of a fiber passing the slot is slight. It is more probable that the fiber will come to the slot in a crosswise position and be backwashed out of the system. Finer cones are generally used farther down in the mill adjacent to the point of requirement for finer cleaned water.

This photograph also shows a series of stainless steel cones, ranging in size from openings of 10 × 10 mesh to 80 × 80 mesh. Finer cones are shown in the next lower

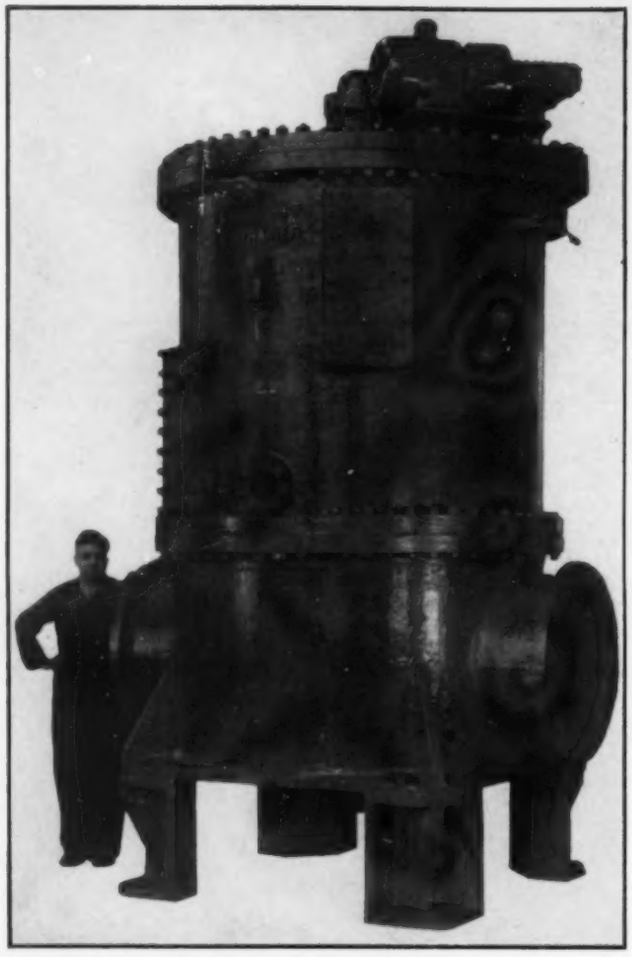


Figure 2 — This 30 in. self-cleaning water strainer can clean 30,000 gpm through a 10 x 10 screen. The photograph shows the motor, outboard bearings, hand holes, backwash connection, inlet and outlet.

row. These are flat screens ranging in mesh from 20 × 20 mesh to a reinforced flat screen which is 200 × 200 mesh. The lower row shows a series of glazed porcelain discs ranging in openings from ⅛ to 1/100 in. These discs are flat and are glazed on the surface which faces the dirty water. Each hole is tapered so that the dirt, if it finds its way into the opening, will be released and allowed to pass on through the system instead of plugging up the strainer. The glazed surface when wet is slick and tends to prevent any material from hanging to the face of the disc.

The coarser porcelain discs having ⅛ in. opening has been used successfully in this district following a traveling screen. This larger opening has recently been made available.

Recirculation of water — In many cases a saving of water may be accomplished by recirculating the water from a pit, at the mill. This partially settled water is carried to a strainer, generally having a stainless steel cone in it, and the water is recirculated with make-up water, for use in the system. By recirculating this water, the mill water is saved and the pump sizes are reduced.

Self-cleaning water strainer — Figure 2, shows a cut of a 30 in. self-cleaning water strainer. This unit is capable of cleaning over 30,000 gallons of water per minute through a 10 × 10 mesh screen at a pressure drop of not over 1½ pounds. This automatic self-cleaning strainer will remove fine particles from the raw or process water, and dispose of these particles in a continuous, automatic and self-cleaning manner. The machine is built in sizes ranging from 3 to 30 in. pipe line sizes.

The strainer consists essentially of a slowly rotating conical drum, mounted on a vertical shaft, within a cast iron housing. The entire surface of the drum is drilled to receive the straining media which consists of porcelain discs, or flat, conical wire stainless steel screens, or bronze slotted cones.

The dirty water, or liquid to be strained, enters through an inlet at the bottom of the housing, see Figure 2, and then rises around the outside of the revolving drum. The discharge of the clean water is through an outlet at the bottom of the housing. The dirty water entering the strainer is under pressure and therefore passes through the straining elements in the drum. The foreign matter in the water is retained on the surface of the perforated porcelain discs, or screens, and is carried in this position, by slow rotation of the drum, to a backwash slot, where the dirt is discharged with the backwash water. This orifice provides a slot which serves as a washout discharge for one vertical row of screening media, see Figure 3. At this slot a reversal of flow takes place, and clean water from the inside of the drum flushes through the screening media and removes the dirt from the strainer.

The differential pressure, between the water in the interior of the drum, and atmospheric pressure, provides an efficient means for backwashing the straining media. The pressure drop through the strainer is 1½ pounds and the backwash water is discharged at atmospheric pressure.

The strainer cone is equipped with a heavy shaft long enough to extend outside of the strainer body. This shaft is provided with a large stuffing box which will operate without leakage. The main reason for bringing the shaft outside of the strainer body is to assure a perfect alinement of the cone and to maintain this alinement with outboard bearings at the top and bottom.

The strainer cone is driven by a gearhead motor and through a special shaft and a stainless steel pinion meshing with a ring gear on the cone. The cone drive mechanism is removable in one complete unit, so that in case of difficulty with the motor; the motor, gear, shaft and pinion may be taken out very quickly and replaced with a new unit.

The cone is arranged with bronze liners top and bottom and the entire cone is adjustable, up and down, to maintain a fine clearance between the drum and the liner. The backwash slots are also equipped with bronze liners.

Strainers for river, lake, canal and well water — Strainers for use on river, lake, canal, or well water are equipped with a chrome-nickel body, cover, and drum casting, stellite bushing and stainless steel pinion. Bronze is used for the ring gear, the liners, and the straining media retaining rings. The straining media are made of porcelain or stainless steel conical screens.

Sea water strainers — The strainers for sea water are

TABLE I

Capacities of Strainers Equipped with Various Types of Straining Media
Gallons per minute

Size, in.	Porcelain discs				Stainless steel wire mesh cones				Slotted bronze cones		
	1/8 in.	1/16 in.	1/32 in.	1/64 in.	10x10	20x20	40x40	80x80	0.035 in.	0.025 in.	0.015 in.
3	267	200	168	128	300	252	192	155	362	288	209
4	453	370	312	238	555	468	357	286	615	489	396
6	1,074	810	680	520	1,214	1,020	780	626	1,457	1,159	843
8	1,869	1,450	1,212	926	2,170	1,820	1,390	1,118	2,535	2,016	1,466
10	2,563	2,250	1,892	1,442	3,380	2,840	2,162	1,730	3,477	2,964	2,310
12	3,905	3,240	2,720	2,070	4,860	4,080	3,110	2,490	5,297	4,212	3,263
16	7,210	6,230	5,250	4,000	9,340	7,880	6,000	4,820	9,779	7,976	6,655
20	11,396	8,925	7,500	5,700	13,390	11,250	8,550	6,850	15,456	12,290	8,938
24	15,716	13,400	11,200	8,500	20,100	16,800	12,810	10,260	21,315	16,948	13,326
30	22,032	20,400	17,000	12,890	30,600	25,500	19,480	15,620	31,680	25,760	19,951

Orifices in 1/16, 1/32 and 1/64 in. porcelain discs are approximately equivalent to 10x10, 20x20, 40x40 screen mesh in wire cone discs.

equipped with ni-resist cones, chrome-nickel body and covers, admiralty metal ring gear and monel metal liners, stellite bushing and sleeve, stainless steel main shaft and pinion gear, and stainless steel retainer rings for stainless or porcelain straining media.

Ammoniacal liquor strainers — Strainers for ammoniacal liquor are equipped with a chrome-nickel body, cover, and revolving drum castings, forged steel ring gear, stellite bushing and stainless pinion gear, stainless steel liners, stainless steel retainer rings for stainless steel or porcelain straining media.

Sand from well water — These strainers have been successfully used for the removal of sand from well water. Sometime ago, the City of Houston installed two, 24 in. strainers and this was followed later by the installation of six, 12 in. strainers.

A complete report of this installation has been made by J. B. Dannenbaum, Plant and Production Engineer, Houston City Water Department, Houston, Texas, before the Texas Water Works Short School at A. & M. College in 1940. Investigations at Houston soon showed that it was impractical to use tankage for settlement of water. The difficult problem consisted of removal of the sand from large quantities of well water. It was found that a velocity of 0.5 feet per second will move coarse sand horizontally and fine sands will move with a lesser velocity. The following tabulation gives the lifting velocities of water required to raise sand particles of various sizes.

Diameter of grains, mm	*Velocity of water, fps*
Up to 0.25	0.00 to 0.10
0.25 to 0.50	0.12 to 0.22
0.50 to 1.00	0.25 to 0.33
1.00 to 2.00	0.37 to 0.56
2.00 to 4.00	0.60 to 2.60

It was found in Houston that 95 per cent of the sand was retained on a 150 mesh screen while the remaining 5 per cent was retained on a 200 mesh screen. Some of the sand particles were approximately 0.0025 in. in diameter so that they would nearly go through a 200 mesh opening. Strainers with 200 mesh screens were installed for handling 15 million gallons per day on two, 24 in. units with a head loss of less than 10 feet. The amount of backwash required in this particular installation did not exceed 1 per cent.

It must be pointed out that such an installation would not operate on a river which contains a large amount of miscellaneous foreign material such as paper, fiber, wood, sand, grit, etc. The strainer would plug up immediately if equipped with a 200 mesh screen. In the case of removal of sand from well water, the foreign material is limited to sand particles of a size which is generally predetermined. In this case a fine screen may be selected and a successful operation will result.

The above examples show clearly the necessity of selecting the proper straining media for any given river, lake, or well water, also the importance of arranging the straining equipment to provide the clean water in the degree necessary for each part of the plant.

Plant water — The above examples show the value of a central cleaning station for eliminating the bulk of the foreign materials in the water before this matter has an opportunity to build up in the mains and spray nozzles. It is also shown the importance of strainers for finer cleaning located at the point of use. The need of proper selection of the correct straining media for each step in the system is shown.

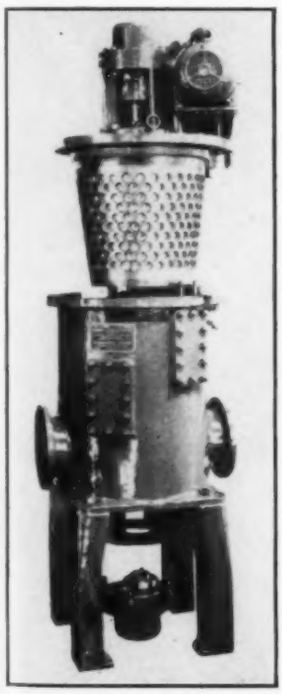


Figure 3 — One row of vertical holes is backwashed at a time.

Report of Activities of AISE STANDARDIZATION COMMITTEE - 1947

By Frank W. Cramer

CHAIRMAN

AISE STANDARDIZATION COMMITTEE

▲ SINCE reporting to the membership at the annual convention last year, much progress has been made as a whole on the Association of Iron and Steel Engineers standardization program. Some programs have had difficulties in advancing, but on the other hand, out of the eighteen projects with which we started the year, five standards have been completed and adopted as AISE standards, having received the approval of the committee concerned, the standardization committee, and the Board of Directors of the Association. One other investigation was completed, but the results did not lend themselves to adoption as a standard. One other program was dropped as the preliminary work indicated that little could be accomplished.

The following research projects are still under way:

1. Crane Ladle Hook Investigation.
2. Design of Hot Metal Ladles.
3. Plain Bearings.
4. Handbook of Lubrication Standards for Steel Industry.
5. Fuel, Furnace, Control and Ceramic Handbook.
6. Flexible and Solid Couplings.
7. Size (Length, Width and Breadth), and Type of Shunting for Motor Brushes.
8. Content and Amount of Dirt in Steel Mill Atmospheres.
9. Steel Mill Lighting.
10. E.O.T. Crane Specifications.

At the spring meeting of the Board of Directors of the AISE which was held on May 25th, the board decided upon recommendation of the committee to drop the project on "Inspection Practices for Mill Buildings." At this meeting the report of the "Turbine Inspection" committee's work was also accepted. No standard was adopted on such inspection as the report indicated that turbine-operating conditions were so varied, that no specific yardstick for requiring inspections could be set up. For example, the interval between inspections in practice varies from 9000 to 35,000 hours. Turbo-generators in steel mill service are usually inspected about every 20,000 hours or somewhat over two years. The interval for turboblowers is about one year.

The following standards were approved and adopted at the spring meeting by the board:

1. AISE Standard Wiring Diagrams for Steel Mill Control.
2. AISE Standard for Machine Surface Finishes.

Presented before AISE Annual Convention, Pittsburgh, Pennsylvania, September 23 and 24, 1947.

At the 1947 annual meeting of the Board of Directors of the AISE which was held last night, the board approved the adoption of the following standards:

1. AISE Sling and Crane Chain Standards.
2. AISE Standard Dimensions for Enclosed Switches.
3. AISE D-c Mill Motor Standards.

We have arranged to have four of the chairmen of the various committees whose standards have been completed to report on them at the Standardization session today or tomorrow. The standards are to be published in the *Iron and Steel Engineer* and reprints will be available. This session has also been so programmed that the D-c Mill Motor Standard, in which there is much interest, can be covered in detail; and we have arranged that Mr. Schnure, the mill motor committee chairman, each of the motor manufacturers, and some of the brake manufacturers be here, both to cover all phases, and to answer any questions which you may wish to bring up.

A number of the programs which are not completed are research programs. One of these, the crane ladle hook investigation, has been going on for several years and is substantially complete. This program will be reported on by Prof. Muhlenbruch of the Carnegie Institute of Technology. Suffice to say for the moment, there are bending stresses in ladle hooks from differential temperature and unequal bearing in the trunnions which are perhaps of more importance than the normal direct and ordinary bending stresses which are usually figured. Prof. Muhlenbruch's work has been primarily aimed at the influence of the laminations in built-up hooks as well as stress and temperature studies on full size hooks on ladle cranes in service at the Weirton Steel Company. To supplement his investigation, a complete stress determination by the photo-elastic method has been made at the Fritz Engineering Laboratory of Lehigh University on models of hooks based on a number of hooks in service in various steel plants. This work has been completed, and is being correlated with the work at Carnegie Tech.

Another very interesting research program which is being sponsored by the Association of Iron and Steel Engineers is the investigation on the "Design of Hot Metal Ladles." This is the most elaborate investigation ever sponsored by the Association next to the crane research which was done several years ago, and will be reported on at this convention. Here again, the stresses which are shown to be actually present by the research work, are very much different than those normally

computed. The results of the program should result in either lighter or better ladles.

Work on revising the AISE Electric Overhead Crane Specifications has gone on for about two years. Most of this has been done by the staff of the AISE. A meeting of the committee was held on March 24 of this year and up to the time of this meeting, it looked as if we had the revision practically completed. However, the question of service factor had come up in both the gearing and motor sections of the specification, and since there seemed to be little actual data or facts available, we decided to actually find out. Consequently, a number of steel plants were surveyed to obtain much detailed data on crane service, broken down into hoist, trolley, and bridge movements. As you know, on some cranes while one motion may have heavy service, the others may have light service. This data was finally completed this month, and tabulated. We should now be ready to go ahead and complete this work.

One meeting of the Plain Bearing committee was held during this year. At this meeting much of the questionnaire data was correlated but more data is required and perhaps some research work before a standard or recommended practice can be adopted.

No work has been done on the "Flexible and Solid Couplings" project during the year, since such standardization is dependent on mill motor standardization. Now that the latter program is completed, work on this item can be started again.

One of our more complex standardization projects is the one, "AISE Standards for Size (Length, Width and Breadth), and Type of Shunting for Motor Brushes." Since the number of varieties number in the thousands, and several plants have demonstrated that the number required can be reduced to little more than a hundred with very marked resultant economies, such standardization on an industry-wide basis is extremely desirable. A proper decision on what sizes to standardize can be reached only on the basis of accurate knowledge of the extent of use and application of the various brushes. The work of collecting this data has gone on during the year. We are still expecting data from one company, and from a large plant of another company.

There is another item that has been brought to the attention of the committee, and will be studied during the coming year. You are all familiar with the National Electric Code which is recognized as the standard for electric wiring and apparatus. It is sponsored by the National Board of Fire Underwriters and accepted as a standard by the American Standards Association.

Table I — Wire sizes for mill type motors as per 1947 National Electric Code.

COL.	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	S	W
	MOTOR FRAME	½ HR. HORSEPOWER	1 HR. HORSEPOWER	5 HR. CONT. H.P.	AMP. RATING FOR ½ HR. H.P. RATING	AMP. RATING FOR 1 HR. H.P. RATING	AMP. RATING FOR 5 HR. CONT. H.P.	WIRE SIZE FOR COL. "E" BASED ON TABLE ON PAGE 243 OF 1947 N.E.C.	WIRE SIZE FOR COL. "F" BASED ON TABLE ON PAGE 243 OF 1947 N.E.C.	WIRE SIZE FOR COL. "G" BASED ON TABLE ON PAGE 342-346 OF 1947 N.E.C.	WIRE SIZES PROPOSED BY ALLIANCE MACH. CO.	M.C.M. AREA OF WIRE IN COL. "H"	M.C.M. AREA OF WIRE IN COL. "J"	M.C.M. AREA OF WIRE IN COL. "K"	C.M. PER AMPERE (COL. "M" ÷ COL. "E")	C.M. PER AMPERE (COL. "N" ÷ COL. "F")	C.M. PER AMPERE (COL. "P" ÷ COL "G")	COL. "G" ÷ COL. "E"
	2	6½	5	3½	29	21	14	#10	#12	#12	12	10.38	6.53	6.53	358	311	466	.48
	3	10	7½	4½	44	31	18	#8	#10	#10	10	16.51	10.38	10.38	375	335	577	.41
	4	13½	10	6	57	40	24	#6	#8	#10	10	26.25	16.51	10.38	460	412	432	.42
	6	19	15	7½	77	57	29	#4	#6	#8	8	41.74	26.25	16.51	542	460	570	.38
	8	33	25	13	126	95	50	#1	#2	#4	6	83.69	66.37	41.74	664	698	838	.39
	10	45	35	18	175	132	68	#2/0	#1/0	#2	4	133.1	105.5	66.37	760	799	976	.39
	12	65	50	22½	245	185	84	#3/0	#2/0	#1	2	167.8	133.1	83.69	685	720	996	.34
	14	100	75	37	368	272	138	300 M.C.M.	#4/0	#4/0	0	300.0	211.6	211.6	815	778	1.533	.37
	16	135	100	46	500	360	170	400 M.C.M.	300 M.C.M.	250 M.C.M.	00	400.0	300.0	250.0	800	833	1,470	.34

Up to and including the 1940 edition, very little was included in the code about crane wiring, regarding wire sizes to be used. In 1943 a supplement was issued which in Article 610 (Cranes and Hoists) contained a table titled "Current-Carrying Capacities of Conductors having Type R Insulation which Supply Crane and Hoist Motors." This table is included in the 1947 edition of the code which has recently been issued. This table lists wire sizes for motors having "30 and 60 minute short time ratings, and motors having 5 and 15 minute short time ratings." Also Article 430 lists 140 per cent of continuous rating for hoist motors and refers to table 20 in chapter 10 for wire sizes. All this is quite confusing to the specification writer for cranes.

The prededing tabulation shows the ampere rating for the 9 standard AISE mill motor frame sizes for ½ hour, 1 hour, and 5 hour ratings, and the minimum wire sizes that should be used according to the 1947 code. It also shows the wire sizes that have been used by the Alliance Machine Company.

This problem has been turned over to a committee whose chairman is Mr. J. E. Bodoh, electrical engineer of the Gary Steel Works for study. This committee has been instructed to draw up recommendations for wiring sizes to be used with both the old and new standard motor frame sizes and to have the report ready for our 1948 convention.

To conclude, during the past year we have completed over one-third of the projects which were authorized at the beginning of the year, and during the coming year we expect to complete about one-half of the remainder. Of course, some projects may be authorized during the year.

In order that the standards will be of maximum benefit, we want to appeal to you to send to the headquarters AISE any criticisms and suggestions which you may have on any standard existing and proposed. In this way only can they be made to suit the majority's requirements. In addition, if our standardization and research program should be expanded to consider additional items, such suggestions should be submitted to insure that work is continued on the most urgent items.

REPORT OF COMMITTEE ON STANDARDIZATION OF DIMENSIONS OF ENCLOSED SWITCHES

By ERIC L. ANDERSON and
A. N. REYNOLDS, JR.
Bethlehem Steel Company

▲ REFERRING to the report of this committee made at the annual convention in Cleveland last year, the committee submitted two possible standards: one, using six size enclosures for the entire line of safety switches from 30-ampere, 2-pole, 230-volt to 200-ampere, 3-pole, 575-volts; and an alternate standard covering four enclosures which would include the standardization of 250-volt, 2-pole, and 575-volt, 3-pole switches. Following this report, a survey was made of the steel industry and the results of this survey showed that the alternate proposal, using the four enclosures and standardizing 250-volt, 2-pole, and 575-volt, 3-pole switches was the desirable standard to follow.

On March 25, 1947, a joint meeting between the safety switch standardization committee and a committee representing NEMA was held in Pittsburgh. The outcome of this meeting was a proposed standard, which the committee recommended for adoption by the Association of Iron and Steel Engineers. This standard was approved by the AISE Standardization Committee, and subsequently by the AISE Board of Directors on September 22, 1947. It is published as AISE Standard No. 2 in this issue.

DISCUSSION

PRESENTED BY

A. G. KYLE, Carnegie-Illinois Steel Corporation

A. N. REYNOLDS, JR., Assistant Superintendent, Electrical Department, Bethlehem Steel Company, Johnstown, Pennsylvania

V. E. SCHLOSSBERG, Superintendent, Electric Power and Steam Departments, Inland Steel Company, East Chicago, Indiana

A. G. Kyle: Have you done anything about standardizing the gage as well as the type of metal?

A. N. Reynolds, Jr.: There was no attempt to standardize either materials or component parts of the switch; in other words, no attempt was made to tie the manufacturer down to any specific standardization other than the mounting.

V. E. Schlossberg: The main purpose of standardization was to let you buy switches from any manufacturer, go ahead and make your layout, and be ready to install them.

REPORT OF COMMITTEE ON STANDARDS FOR MACHINED SURFACE FINISHES

By HUGH B. CONOVER
Carnegie-Illinois Steel Corporation

▲ The Board of Directors of the Association of Iron and Steel Engineers on May 25, 1947 approved Standards for Machined Surface Finishes for the industry. The purpose of these standards is to define surface finish; that is, the degree of roughness of the surface in measurable terms.

The unit of measurement is the micro-inch, which is one-millionth of an inch. Each finish is specified in two ways: Micro-inches "average" roughness and micro-inches "average peak to valley" roughness. "Average" roughness is the root mean square or arithmetical deviation from the mean surface. "Average peak to valley" roughness is the average height from peaks to valleys.

There are ten standards. Each standard is identified by one of the first ten letters of the alphabet, by a name, by the maximum "average" roughness expressed in micro-inches, and by the maximum "average peak to valley" roughness expressed in micro-inches. Regardless of the material or method of processing used on the finished product, the micro-inches specified in the standards represents the maximum roughness acceptable for each symbol.

The ten standards cover the range of machined finishes required in the steel works from the very fine finishes of 4 micro-inches "average" required for pre-

cision equipment to the very rough finish of 2000 microinches "average" where metal is removed for clearance only.

The reason for developing and adopting standards is to enable one set of people to convey to another set of people an exact description of the surface finish they require to be furnished (on any designated surface) in understandable and measurable terms.

There is on the market a set of 10 sample blocks, one for each of the AISE standards, that illustrate each finish. These blocks are very valuable in selecting the finish desired, and also very valuable to those who must duplicate the finish specified. Any other set of blocks that meet the specification requirements would be equally acceptable.

The standard does not specify what finish is to be used for any particular application, nor does it define what finish is required with various tolerances or materials.

In use, the desired finish for each surface is selected from the sample blocks, and the letter designating that standard finish is placed in, on or along side of the finish mark for that surface.

The finish mark may be the triangle with the designating letter inside, the check mark with the designating letter in the "V," the customary "*f*" with the designating letter placed close to it, or any other designation that is customary with each company or works.

In those cases where only one or several surfaces require specific finishes, it is only necessary to designate the standard finishes required, leaving the others to the shop. Experience has shown, however, that the difference in cost between the smoothest standard finish and the roughest standard finish is approximately 40 to 1. It is evident, therefore, that considerable saving is available if time is not wasted producing finishes smoother than are required.

Usually the finish on the machined surface can be identified by comparing it with the sample by visual inspection or by using a pointed hand tool or finger nail. Where necessary the roughness can be measured. One instrument for this purpose is a profilometer. This standard is published as AISE Standard No. 3 in this issue.

REPORT OF COMMITTEE ON SLING AND CRANE CHAIN STANDARDS

By J. B. MITCHELL and
J. F. BYERS
Jones and Laughlin Steel Corporation

▲ THE purpose of this project initiated in November 1945, has been to accumulate data suitable for standardization of dimensional factors, strength properties and permissible wear of iron and steel sling and crane chain.

A draft of the standard prepared by the sling committee was sent to the Standardization Committee on March 15, 1947 for approval. At that time, twelve of the committee members voted for approval, and four members did not vote. However, several members had suggestions for changes.

The standard was re-written to incorporate most of these suggestions, and sent again to the committee for approval on June 30, 1947. Fourteen votes have been received for approval, and two members have not voted. No criticisms have been received on this revision. This standard was adopted by the AISE Board of Directors on September 22, 1947. It is published as AISE Standard No. 4 in this issue.

DISCUSSION

PRESENTED BY

L. J. GOULD, Chief Engineer, Construction, Bethlehem Steel Company, Bethlehem, Pennsylvania

L. J. Gould: I am somewhat concerned about the distribution and use of these chain specifications. The American Chain Institute and the manufacturers of chains were in the past very generous with charts, showing a factor of 3 to 3½ which apparently are in the standards shown. At the bottom of those charts when it came directly from the Chain Institute, there were printed so many qualifications that you were led to realize that the 3½ factor of safety was sufficient only if you suspended the load very gradually with the chains under the most favorable conditions. Unfortunately these charts were reprinted by various interested groups without the warning attached and in any case it seems likely that few read the fine print at the bottom of the chart.

We got into this problem in one of our plants about 15 years ago. At that time, we were using wrought-iron chains. We found that the safety factor was inadequate because the crane follower could not be expected to calculate acceleration and deceleration, nor did he worry too much about sharp corners and twisted links. In an attempt to find out what would be safe we examined the records on chains which carried a reasonably known load repeatedly and found that the chains had designed themselves for the job in many cases. In other words, we found instances where a ⅜ in. chain had been originally specified and had failed, and this had been replaced by a ½ in. chain which perhaps also failed a little less rapidly and a final larger size had lasted a long while. An analysis of these cases showed that the chains had designed themselves to a factor of safety of more nearly 5 than the 3 to 3½ so frequently quoted. This factor we assume covered not only our ignorance as designers, but a reasonable amount of carelessness on the part of the operator. It is to be hoped that the Standards Committee will make sure that with this standard of chain they will furnish to the industry prominent warnings of the effect of impact, sharp edges, twisted links and the other mistreatments generally given in handling equipment.

AISE STANDARD NO. 2

STANDARD DIMENSIONS FOR ENCLOSED SWITCHES

1. Purpose
   a. The purpose of this specification is to establish a standard for the pertinent mounting dimensions of safety switch boxes for steel mill use, so that switches may be mounted interchangeably (regardless of make). The standard does not cover materials or components.

2. Scope
   a. The standards apply only to Type A Switches in Class 1 enclosures. Outdoor and special switches are not included.

   b. The standards apply to 250 volt, 2 pole switches with 30, 60, 100 and 200 ampere capacities, and 575 volt, 3 pole switches in 30, 60, 100 and 200 ampere capacities. The demand for the 250 volt, 3 pole, and 575 volt, 2 pole is insufficient to warrant standardization for these sizes.

   c. Both fusible and non-fusible switches will use the same box size. When a non-fusible switch is required, a copper bar will be used in place of the fuse.

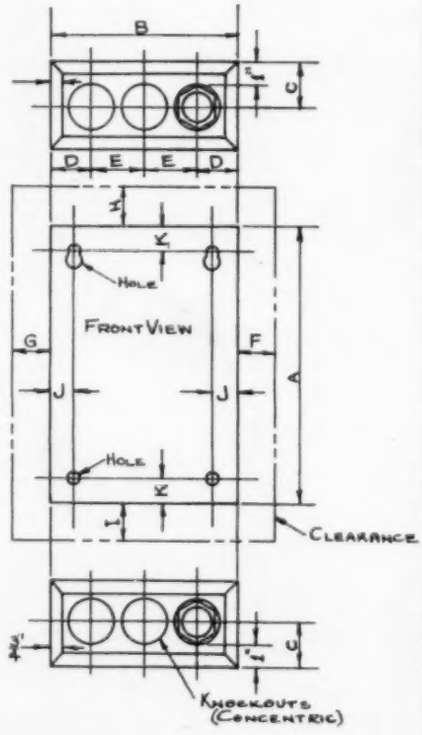
   d. Location, size, and number of knockouts are standardized.

3. Standards
   a. Standard dimensions will be as shown on Figure 1 for the four standardized enclosure sizes.

   b. The following ratings will be used in the four enclosures:
   Enclosure No. 1 — 30 amp, 250 volt, 2 pole
   Enclosure No. 2 — 60 amp, 250 volt, 2 pole
   30 amp, 575 volt, 3 pole
   60 amp, 575 volt, 3 pole
   Enclosure No. 3 — 100 amp, 250 volt, 2 pole
   100 amp, 575 volt, 3 pole
   Enclosure No. 4 — 200 amp, 250 volt, 2 pole
   200 amp, 575 volt, 3 pole

   c. All switches must be approved by the Underwriter's Laboratories and meet National Electric Code requirements.

Figure 1 — Required standard dimensions for enclosed switches are illustrated by this sketch and table.



ENCLOSURE	No1	No2	No3	No
A	11	17½	24	3
B	7½	10½	13	15
C	1⅞	2⅝	2¾	2
D	2	2½	3⅛	4
E	1¾	2¾	3⅜	3
F	3	3	3	3
G	2½	3	3½	4
H	⅝	⅝	⅞	
I	⅛	⅛	⅛	
J	1	1	1½	1
K	1	1	1½	1
HOLE	5/16	5/16	7/16	
KNOCKOUTS	½	¾	1	1
	¾	1	1¼	2
	1	1¼	1½	2
		1½	2	
30 AMP 250 VOLT 2 POLE	☒			
60 AMP 250 VOLT 2 POLE		☒		
100 AMP 250 VOLT 2 POLE			☒	
200 AMP 250 VOLT 2 POLE				☒
30 AMP 575 VOLT 3 POLE		☒		
60 AMP 575 VOLT 3 POLE		☒		
100 AMP 575 VOLT 3 POLE			☒	
200 AMP 575 VOLT 3 POLE				☒

ALL DIMENSIONS IN INCHES.
DIMENSION "E" BASED ON ¼" CLEARANCE BETWEEN CORNERS OF LOCKNUTS OF LARGEST CONDUIT IN THE CONCENTRIC KNOCKOUT GROUPS.
KNOCKOUTS LISTED IN CONDUIT SIZES.
☒ DENOTES RATING OF SWITCHES FOR ENCLOSURE.

AISE STANDARD NO. 3

STANDARDS FOR MACHINED SURFACE FINISHES

1. Purpose
   a. The purpose of this standard is to define surface finish in measurable terms. Inasmuch as tests have shown that the cost ratio between the finish of an average 4 to an average of 2000 micro-inches is 40 to 1, very marked savings are possible through the selection of the proper finish.
2. Scope
   a. This standard covers the range of machine finishes required in the steel plant from the very fine finishes required for precision equipment to the very rough finish which is sufficient where metal is removed for clearance only.
   b. This standard does not specify what finish is to be used for any particular application, nor does it define what finish is required with various tolerances or materials. The standard is merely intended to provide a specific means of conveying the requirements of the engineer to the machine shop, and also to provide the engineer with a visual sample that he may use in specifying machine finish.
   c. This standard includes a drawing symbol which is recommended for use on drawings specifying surface finish. This symbol is correlated with the sample blocks which are a part of the standard.
3. Standards
   a. Standard finishes will correspond with the data and terminology which is enumerated in Table I — Classification of Machine Surface Finishes.
   b. The symbols to be used on drawings specifying the surface finishes will contain the letter as shown in Table I — Classification of Machined Surface Finishes, to indicate the class of finish. These letters may be keyed with a triangle as shown, check mark, "f" mark, or any other standard finishing symbol.
   c. The standard roughness specimens to be used in this specification will correspond to the dimensional requirements given in Table I — Classification of Machined Surface Finishes. The General Electric Company manufactures a set of roughness specimens which correspond to this specification, although any other set which may be manufactured in the future will be accepted, provided it meets the specification requirement outlined in Table I.

Table I — Classification of Machine Surface Finishes.

Symbol	Class	Roughness micro-inches: Average	Roughness micro-inches: Average peak to valley	Suitable for tolerances of plus or minus unless otherwise specified, in.	Definition of finish	Typical method of producing finish (does not include all methods)	Approximate relative cost to produce
* A	Super finish	4	15	0.0005	Mirror like surface without tool, grinding or file marks of any kind.	Ground, micro-honed, lapped, burnished, buffed, to best surface possible.	40
* B	Polish	8	28	0.0005	Smooth finish with very close tolerance limits and without scratches.	Ground, honed, lapped, burnished, etc.	35
* C	Ground	16	56	0.001	Smooth finish with close tolerance limits.	Ground, rolled, filed, lapped, etc.	25
* D	Smooth	32	118	0.002	Bearing surface where accuracy is essential and tool marks objectionable.	Square nose tool with drag feeds to suit. Ground, rolled, filed, milled, etc.	18
* E	Fine	63	220	0.003	Smooth surface without objectionable tool marks; moderately close tolerance.	Shaped, milled, ground, reamed, rolled, broached, etc.	13
* F	Semi-fine	125	455	0.004	Surface requiring good finished appearance or where fairly close dimensional accuracy is essential.	Shaped, ground, broached, milled, etc.	9
* G	Medium	250	875	0.007	Where good surface is essential, such as machined parts, etc.	Shaped, rough ground, milled, turned, bored, drilled, spot-faced, etc.	6
* H	Semi-rough	500	1750	0.013	Where close tolerance is not required for parts that fit together in bolted or riveted assembly, when uniform bearing area is needed.	Shaped, rough ground, milled, turned, bored, etc.	4
* J	Rough	1000	3500	0.025	Rough surface produced by removing stock to nominal dimension.	Round nose tool, $\frac{1}{64}$ to $\frac{1}{4}$ in. feed.	2
* K	Clean up	2000	7000	0.050	Very rough surface produced by removing excess stock to approximate size for clearance or appearance.	Round nose tool, $\frac{1}{64}$ to $\frac{1}{32}$ in. feed.	1

*Refers to General Electric standard roughness specimens.
Method and procedure of obtaining the various required finishes may vary according to size, shape, design, or contour of the work.
Comparisons are generally made by sight and feel methods.
Regardless of the material or method of processing used on the finished product, each specimen represents the roughest surface acceptable for each symbol.
In general, average values were determined by a Profilometer, and "average peak to valley" values, by a brush surface analyzer or a profile recorder.

AISE STANDARD NO. 4

SLING AND CRANE CHAIN STANDARDS

INTRODUCTION

▲ DATA for this standard are based mainly on material prepared by the Chain Institute, Inc., The American Standard Safety Code for Cranes, Derricks, and Hoists, and ASTM Standards for sling and crane chains, and these standards are based mainly on the strength properties of chain, on the assumption that the purchaser of chain is chiefly interested in the strength and weight lifting capacity of the material.

Scope of this material includes data on strength properties, link dimensions, chain weights, and inspection and wear data for wrought iron and proof coil chain; strength properties and inspection and wear data only, for high test and alloy steel chain. It does not cover stud link anchor chain, corrosion resistant steel, acid resisting bronze, monel metal, or chain over two inches in size. Proof coil chain is not permitted for sling and crane chains in most mills, but is here included to cover those mills which still permit its use.

The physical properties are given in most cases as averages because of the variation in the practice of the manufacturers. Properties should not deviate too markedly below these averages. Minimum breaking load and proof test load requirements must be met.

CHAIN STANDARDS

I. WROUGHT IRON SLING AND CRANE CHAIN

A. Chemical and physical properties of wrought iron sling and crane chain must meet the following requirements:

1. Approximate composition — 0.06 per cent carbon maximum, 0.06 per cent manganese maximum.
2. Average physical properties:

a. 47,000 psi tensile strength.
b. 28,000 psi yield strength.
c. 15 per cent elongation in a gage length of 12 to 18 in. to the nearest link.
d. 40 per cent reduction of area.

B. Link dimension and chain weights for wrought iron sling and crane chain shall be in accordance with the values in the following table. The length of 100 links and the weight per 100 ft shall not vary more than 4 per cent plus or minus from the values prescribed in Table I.

TABLE I

Wrought Iron Chain Dimensions

Trade size, inches	Material size, inches	Inside length of link, inches	Inside width of link, inches	Approximate number of links per foot	Weight per 100 ft in pounds
3/8	13/32	1 3/32	5/8	11	166
1/2	17/32	1 11/32	3/4	9	275
5/8	21/32	1 11/16	7/8	7	430
3/4	25/32	1 7/8	1	6 1/2	615
7/8	29/32	2 1/4	1 1/4	5 3/8	820
1	1 1/32	2 9/16	1 3/8	4 3/4	1045
1 1/8	1 5/32	2 7/8	1 5/8	4 1/4	1310
1 1/4	1 9/32	3 1/16	1 3/4	3 7/8	1600
1 3/8	1 13/32	3 5/8	1 7/8	3 1/4	1930
1 1/2	1 17/32	3 7/8	2	3 1/8	2335
1 5/8	1 21/32	4 1/4	2 1/8	2 3/4	2740
1 3/4	1 25/32	4 3/4	2 1/4	2 1/2	3180
2	2 1/32	5 3/4	2 5/8	2 1/16	4100

C. Strength properties of wrought iron sling and crane chain shall be in accordance with Table II.

TABLE II

Wrought Iron Chain Loads

Trade size, inches	Minimum breaking load, pounds	Minimum proof test load, pounds	Safe working load, pounds
3/8	7,950	3,020	2,385
1/2	14,145	5,375	4,240
5/8	22,095	8,395	6,630
3/4	31,800	12,080	9,540
7/8	43,245	16,430	12,960
1	56,550	21,490	16,950
1 1/8	66,800	25,380	20,040
1 1/4	82,500	31,350	24,750
1 3/8	99,800	37,920	29,910
1 1/2	118,700	45,100	35,600
1 5/8	139,500	53,000	41,800
1 3/4	161,600	61,400	48,450
2	211,100	80,200	63,300

D. Annealing treatment of wrought iron sling and crane chain.

The following periodic heat treatment of wrought iron chain only is generally employed to remove the effect of work hardening. The material should be thoroughly and uniformly heated at the temperature indicated.

Diameter of chain, inches	Annealing temp, F	Time at temp, hr	Cool in
1/4 to 1/2	1350-1375	1/2	Air
5/8 to 1	1350-1375	1	Air
1 1/8 to 1 1/2	1350-1375	1 1/2	Air
1 5/8 to 2	1350-1375	2	Air

Heat should thoroughly penetrate the work and the top, center, and bottom of the charge should reach approximately the same temperature. After the chain has been held at the annealing temperature for the specified time, it should be allowed to cool uniformly in air to room temperature. Sufficient space must be left between the chain so as to insure uniform cooling.

The period between annealings will depend on the amount of cold working to which the chain is subjected. However, chains shall be annealed at intervals not exceeding six months. One guide which is sometimes used is that annealing is required when the chain has stretched 1 in. in 3 ft. In using this criteria, the 3 ft length must be marked on the chain prior to use and after annealing.

After annealing, the chain should be proof tested and re-inspected for weld defects and defective links.

II. PROOF COIL CHAIN

A. When proof coil chain is used for overhead work (a practice which is not approved by many mills), the chain shall meet the following requirements:

1. The amount of phosphorous and sulphur in the chain material shall not exceed 0.05 per cent for either item.
2. The link dimensions and chain weights of proof coil chain shall be in accordance with the values in the following table. The length of 100 links, and the weight per 100 ft shall not vary more than plus or minus 4 per cent from the nominal weight prescribed in Table III.

TABLE III

Proof Coil Chain Dimensions

Trade size, inches	Material size, inches	Inside length of link, inches	Inside width of link, inches	Approximate number of links per foot	Weight per 100 ft in pounds
1/4	3/32	1	1/2	12	70
5/16	1/8	1 7/64	1/2	10 3/4	105
3/8	5/32	1 11/64	5/8	9 3/4	158
7/16	3/16	1 3/8	3/4	8 3/4	210
1/2	7/32	1 1/2	9/16	8	265
9/16	1/4	1 3/4	7/8	6 7/8	335
5/8	9/32	1 7/8	1	6 3/8	410
3/4	5/16	2 1/8	1 1/8	5 5/8	580
7/8	3/8	2 1/2	1 3/8	4 3/4	780
1	1 1/32	2 3/4	1 1/2	4 3/8	1000

3. The strength properties of proof coil chain shall be in accordance with Table IV.

TABLE IV

Proof Coil Chain Loads

Trade size, inches	Minimum breaking load, pounds	Minimum proof test load, pounds	Safe working load, pounds
1/4	3,400	1,700	850
5/16	5,300	2,650	1,325
3/8	7,700	3,850	1,925
7/16	10,500	5,250	2,625
1/2	13,700	6,850	3,425
9/16	17,300	8,650	4,325
5/8	21,400	10,700	5,350
3/4	30,700	15,350	7,675
7/8	41,800	20,900	10,450
1	54,700	27,350	13,675

III. HIGH TEST STEEL CHAIN

A. Chemical and physical properties of heat treated chain shall meet the following requirements:

1. Composition shall approximate that of the class of steel known as the SAE 1020 grade.
2. Physical properties:
   a. 85,000 psi tensile strength average.
   b. 55,000 psi yield strength average.
   c. 45 per cent reduction of area.

TABLE V

High Test Steel Chain Loads

Trade size, inches	Minimum breaking load, pounds	Minimum proof test load, pounds	Safe working load, pounds
1/4	8,130	4,275	2,150
5/16	11,495	6,050	3,025
3/8	16,150	8,550	4,275
7/16	21,090	11,100	5,550
1/2	26,600	14,000	7,000
9/16	33,250	17,500	8,750
5/8	38,475	20,250	10,125
3/4	53,200	28,000	14,000
7/8	72,675	38,250	19,125
1	92,150	48,500	24,250
1 1/8	114,950	60,500	30,250
1 1/4	142,500	75,000	37,500

d. 28 per cent average elongation, but minimum must not be less than 20 per cent, in a gage length of 12 to 18 in. to the nearest link.

B. Strength properties of high test steel shall be in accordance with Table V.

IV. ALLOY STEEL CHAIN

A. The chemical composition may vary in accordance with the practices of the various manufacturers, but should approximate SAE 2320, SAE 4615, and SAE 4620. Carbon content should not exceed 0.25 per cent.

B. The physical properties after heat treating will be as follows:
1. 125,000 psi average tensile strength.
2. 100,000 psi average yield strength.
3. 60 per cent average reduction in area.
4. 15 per cent minimum elongation in a gage length of 12-18 in. to the nearest link.

C. The strength properties of alloy steel chain shall be in accordance with Table VI.

TABLE VI

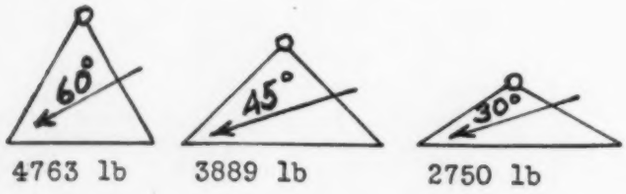
Alloy Steel Chain Loads

Trade size, inches	Minimum breaking load, pounds	Minimum proof test load, pounds	Safe working load, pounds
1/4	9,975	5,500	2,750
5/16	15,200	8,800	4,400
3/8	21,375	13,200	6,600
7/16	28,500	17,600	8,800
1/2	38,475	22,500	11,125
9/16	47,000	27,500	13,750
5/8	56,525	33,000	16,500
3/4	73,625	46,000	23,000
7/8	98,800	57,500	28,750
1	128,250	77,500	38,750
1 1/8	169,100	89,000	44,500
1 1/4	218,500	115,000	57,500

V. MULTIPLE SLING CHAINS

The angle between the legs of the branches of a sling chain should always be taken into consideration. Increase of this angle decreases the angle between the legs and the horizontal. The tension in each leg is thereby increased and the safe working load reduced. The safe working load of a sling chain can be calculated by multiplying the sine of the angle between the legs and the horizontal by the safe working load of the chain when used as a vertical sling chain and multiplying the result by the number of chains. For example:

Size	*Safe working load of single chain*
1/4 in.	2750 lb



VI. GENERAL INFORMATION

Proof test — The proof test is the actual load in pounds applied to the complete sling chain assembly by the manufacturer before shipment of the chain and should not be construed as the safe working load. Usually the proof test is twice the safe working load, except for wrought iron chain.

Marking — No markings should be stamped on the links of the chain. Metal tags should be attached to the end of each chain, stamped with type of chain, such as Proof Coil, High Test Steel, etc.

VII. SLING CHAIN INSPECTION

Sling chain should be periodically inspected for the following defects, and, unless full and adequate repair facilities are available, chain showing these faults should be returned to the manufacturer for re-conditioning.

A. Stretch and clearance between links.
B. Bent links.
C. Cracks in weld area or any other section of link.
D. Scores or markings tending to weaken links.
E. Corrosion pits.
F. Lifted fins. On electric or forge welded chain lifted fins usually indicate overload.
G. Excessive peening, particularly in iron chain.
H. Check rings, pear shaped links and hooks for all above defects.
I. Check hooks for opening.
J. Wear. Chains will be removed from service when the increase in length of the measured section (5 links or 1 to 3 ft) exceeds 20 per cent, or when the wear exceeds that given in Table VII.

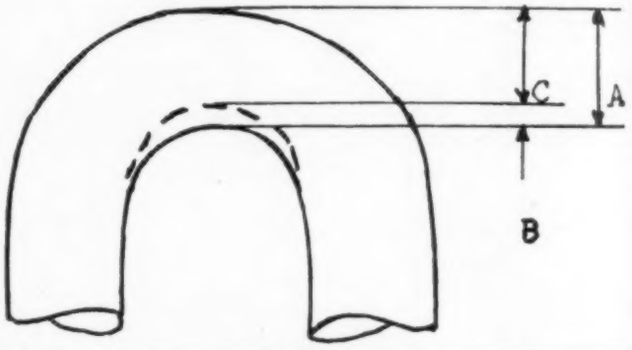


TABLE VII

Permissible Wear of Chain

Trade size, inches	Maximum permissible wear, inches	Minimum safe dimension, inches
A	B	C
1/4	3/64	15/64
5/16	3/64	19/64
3/8	1/16	11/32
7/16	5/64	25/64
1/2	5/64	29/64
9/16	3/32	1/2
5/8	3/32	9/16
3/4	7/64	43/64
7/8	1/8	25/32
1	9/64	57/64
1 1/8	5/32	1
1 1/4	5/32	1 1/8
1 3/8	11/64	1 15/64
1 1/2	3/16	1 11/32
1 5/8	13/64	1 29/64
1 3/4	7/32	1 9/16
1 7/8	15/64	1 43/64
2	1/4	1 25/32

AISE STANDARD NO. 5

STANDARDS FOR WIRING DIAGRAMS

. . . . This standard was developed by a combined AISE-NEMA committee and is now being considered for approval by the Codes and Standard Committee of the NEMA . . . .

1. Scope
   a. The following rules apply to diagrams for all control designed especially for steel mill service. This includes main and auxiliary mill drives, processing lines, cranes, etc. They do not apply to catalog controllers (such as line starters) used in steel mills.
2. Sizes
   a. The following sizes are standard, and agree with ASA-Z14.1:
      1. 8½ in. × 11 in.
      2. 11 in. × 17 in.
      3. 17 in. × 22 in.
      4. 22 in. × 34 in.
   b. For diagrams requiring more space, use multiple sheets of 22 in. × 34 in. size, with match lines.
3. Content of Diagram
   a. The wiring diagram shall include:
      1. Panel internal connections:
         Rear view of wiring shall be shown when the principal wiring and external connections are to be made on the rear of the panel. Front connected panels shall be shown by a front view. When there are connections to both front and rear, the major wiring shall determine the view, and the minor wiring shall be indicated as being on the opposite side of the panel. All control wires are to be numbered, and machine connections identified in accordance with ASA-C6. Mechanical interlocking between devices is to be indicated. If notes are used to explain the interlocking, the indication must be shown in addition. The internal panel connections may be shown by lines, or the so-called "wireless" method may be used.
      2. Panel external connections:
         All external connections shall be shown and the wires numbered, and the machine connections identified in accordance with ASA-C6.
      3. Elementary diagram:
         All control wires shall be numbered.
         Mechanical interlocking of devices may be covered by notes without using dotted lines. The ohms and continuous watt capacity of control circuit resistors shall be shown. They may be included in "Functional list of contactors and relays," paragraph 3, a, (7).
         The voltage and capacity of capacitors shall be shown, and may be included in "Functional list of contactors and relays," paragraph 3, a, (7).
         If it is not practical to show ohms, watts, voltage, capacity, etc., on the elementary diagrams, the information shall be included in an instruction book, with spare part data.
         Where practical, the elementary diagram shall be located in the lower right corner of the wiring diagram, and confined to a space 8½ × 11 in., which space will include the title block, and "Contactor sequence chart," paragraph 3, a, (5), and "Functional list of contactors and relays," paragraph 3, a, (7). This permits clipping the elementary for separate filing. If more space is required, confine the elementary to the right hand side of the diagram above the title block. If the elementary diagram requires a separate sheet, its number shall be cross indexed with that of the wiring diagram.
      4. Master controller sequence chart:
         Where master controllers are shown in accordance with ASA-Z32.3, the diagram of the master automatically becomes a sequence chart.
      5. Contactor sequence chart:
         This chart should show the contactors which are closed in each position of the master controller, and indicate those which may or may not be closed as determined by the operation of automatic devices.
         If the chart is too complicated to be shown on the diagram, it may be included as a part of the operating instructions. A sequence chart is not required for single speed (pushbutton) controllers.
      6. Identifying information:
         Diagrams, including those shipped with the controller, must be identified by including on them the following information:
         A. Manufacturer's order number.
         B. Ultimate user's name (if obtainable).
         C. Ultimate user's order number, (if obtainable).
         D. Drive identification.

E. Cross reference to the resistor diagram.
When a diagram is made specifically for a certain drive, and there is little chance of it being used for another order, the identifying information may be placed on the tracing above the title block.
When the diagram is more or less standard, and will probably be used for other orders, the identifying information should appear on the back of the blueprints, or be typed on a sticker pasted to the blueprints. Still another method is to leave a blank space on the tracing and fill it in on the prints.

7. Functional list of contactors and relays:
Example 1F-2F, forward direction contactors.
1A-2A-3A, armature accelerating contactors.

4. General
   a. Symbols should agree with ASA-Z32.3.
   b. Device markings should agree with NEMA-1C51-10.
   c. Machine markings should agree with ASA-C6.1.
   d. Abbreviations should agree with ASA-Z32.13.
   e. The name plate on the control panel shall include the number of the diagram, or diagrams.
   f. All wire terminations (studs and lead holes) on the rear of the control panel are to be numbered to correspond with the diagram. The manufacturer's number of all coils and devices, and the operating voltage, will be supplied as spare parts data.
5. Resistor diagrams
   a. Resistor construction diagrams are to include:
      1. Ohms of each step.
      2. Continuous amperes capacity of each step.
      3. NEMA class number.
      4. Identifying information as covered by paragraph 3, a, (6) above.
6. Definitions
   a. *Schematic diagram* — A schematic diagram is an illustrative diagram whose principal purpose is to show the operating principle of a device or group of devices without necessarily showing actual connections or circuits. Schematic diagrams may use pictures or symbols to illustrate or represent devices or their elements. (They are applicable chiefly to instruction books, descriptive folders, or other mediums whose purpose is to explain or instruct.)
   b. *One-line diagram* — A one-line diagram is one which indicates by means of single lines and simplified symbols, the course and component devices or parts of an electric circuit or system of circuits. (One-line diagrams are useful in showing the over-all relations between component devices of circuits and between circuits, such as for power circuits and switch gear.)
   c. *Elementary diagrams* — An elementary diagram is one which shows all circuits and device elements of an equipment and its associated apparatus, or any clearly defined functional portion thereof. Such a diagram emphasizes the device elements of a circuit as distinguished from the physical arrangements of the conductors, devices, or device elements of a circuit system. (Elementary diagrams are useful where electrical relationships of circuits and device elements are the principal considerations).
   d. *Connection diagrams* — A connection diagram is one which shows the connections of an installation or its component devices and equipment. They may cover internal or external connections or both, and contain such detail as needed to make or trace the connections that are involved.
   e. *Construction diagram* — A construction diagram is a diagram whose purpose is to show features of construction specifications in simplified form. (A construction diagram is useful to show the stacking of resistor grids, rectifier discs, etc.)

IMPROVED D-C GENERATORS FOR REVERSING MILLS

By C. LYNN and W. H. BURR

(*Continued from page 55*)

getting the equivalent of a half turn on the heavy current coils, and ordinarily no magnetic unbalance will occur when one circuit carries more current than the other, as the correct procedure is to have all north poles in one circuit and all south poles in the other circuit.

Motors, like the mills themselves, are becoming more complicated and more compact due to the requirements of higher speeds in rolling steel. The stands are closer together and the motors must, therefore, be physically smaller. Many motors are located directly in the mill, which means they must be totally enclosed, and as such are more inaccessible for cleaning. Due to the pressure of getting out steel, the maintenance departments are allowed too little time for good maintenance and cleaning of the motors with the results that the motors become abused from the standpoints of the adverse conditions under which they must operate.

Walter Burr: I made an inspection of the generator which you have heard described, and found the commutation and the condition of the commutator to be very good. We have started to make the changes in the second generator. Parts have been assembled and will be put in the frame of the generator in the very near future.

So far the results we have obtained from the change have been very satisfactory. Commutation has been very good and the cost of maintenance is, we feel, going to be very greatly reduced.

Mill Motor Brake Standardization

. . . . the following discussion on the possibility of standardizing brakes for mill motors took place at the Standardization Session of the 1947 AISE Annual Convention . . . . the adoption of the new AISE mill motor standard requires review of motor brake design and makes this an appropriate time to study the question of brake standardization . . . . V. E. Schlossberg, Inland Steel Company, has recently been appointed chairman of the AISE Mill Motor Brake Standardization Committee . . . .

EFFECT OF PROPOSED NEW AISE MILL MOTORS ON MOTOR BRAKE DESIGN

By A. H. MYLES, Assistant Chief Engineer,
Electric Controller and Manufacturing Company,
Cleveland, Ohio

▲ IN applying direct current magnetically operated brakes to motors driving various types of machines, many considerations are required with respect to torque, brake coil heating, and operating characteristics. The brake may be mounted on a d-c mill type motor, a crane type motor, a general purpose d-c motor or, with suitable rectifying equipment, on any type of a-c motor. The torque ratings for motors of the same horsepower vary considerably between types of motors because of differences in full load speed.

In most applications, a brake having a torque rating equal to the rated full load torque of the motor is entirely satisfactory. However, many applications require a brake torque greater or less than the rated full load torque of the motor. For example, a brake may be mounted on an intermediate drive shaft rather than on the motor shaft, and the torque required may be considerably in excess of the full load torque of the motor. Other brakes may be used to assure an unusually quick stop for safety reasons or to meet a required duty cycle. Still other brakes may be used for "parking service" that is, for holding a drive stationary when moved into position. For this service, very little torque is required relative to the motor full load torque.

For some applications a large factor of safety in the value of brake torque is desirable. Because of differences in efficiency, a different brake size may be required for similar drives using the same motor to provide the same factor of safety. For example, a crane hoist of very low efficiency requiring a motor having a 30 minute rating of 50 hp might use a brake having 525 lb ft torque and provide a factor of safety of 30 to 40 per cent. On the other hand, a very high efficiency hoist requiring the same horsepower would have very little factor of safety if the same brake were selected.

Our experience indicates that approximately the same number of brakes are used with other types of motors as with mill type motors, consequently any attempt to standardization of brakes in terms of their torques should recognize the wide variety of motor and brake applications.

Standardization of brake torque ratings in accordance with some "preferred number system" might provide a logical and final solution to the problem. For example, if we were to assume seven brake sizes to be economical in covering the range of torque from 100 to 6400 lb ft, then a "preferred number system" would give standardized torques of 100, 200, 400, 800, 1600, 3200 and 6400 lb ft. At first glance it might appear that greater usage of a motor of some particular frame size should influence the torque rating for brake standardization. However, if this were done, the brake torque standards would continually be subject to modification with changes in motor design.

Considering dimensions, motors of the 600 series have a lower shaft center line than previous mill motors or general purpose motors. Any standardization requiring the brake base to wheel center line to be equal to or less than the motor base to shaft center line places a definite restriction on brake design.

With the new 600 series of mill motors, I understand that AISE intends to recognize only their 60 minute rating. Regarding brakes, the 30 minute and 60 minute series coil current ratings are in close agreement with the corresponding 30 and 60 minute rated full load motor currents. Series brake coils so selected will release the brake on 40 per cent of the motor full load 60 minute current with a 60 minute brake torque setting or on 40 per cent of the motor full load 30 minute current with a 30 minute brake torque setting. However, brake torque adjustment must correspond to the 30 or 60 minute torque of the motor in accordance with the way the motor is applied.

Presented before AISE Annual Convention, Pittsburgh, Pennsylvania, September 23, 1947

The 60 minute motor rating only may lead to more serious confusion from the point of view of components of control other than brakes. This is because the motors for many applications will still be selected and used on the basis of the motor's 30 minute ability. In designing control and resistors we must recognize both the 30 minute and 60 minute rating of the motor to get satisfactory results because of the known duty cycle of many applications. For example, a frame 608 mill motor rated 35 hp, 60 minutes for crane hoist service would not operate satisfactorily if 35 hp control and resistors were supplied. The duty requirements of crane hoists correspond to that of motors at their 30 minute rating or, in this example, 45 hp. The component parts of the control have much less thermal capacity than the motor and brake and must be supplied on a 45 hp basis. The capacity and ohmic value of the resistor must also be supplied on the 45 hp basis in order to provide satisfactory torque and speed for the drive.

It is hoped that the points I have outlined will be given consideration before proceeding further with any brake standardization program.

AISE MILL MOTORS AND BRAKE STANDARDIZATION

By JOHN A. CORTELLI, Chief Engineer,
Clark Controller Company, Cleveland, Ohio

▲ THE invitation to discuss the effect of the new Mill Motor Standards upon brake applications to these motors immediately raised a question in our minds. Particularly because this was a meeting on standardization. The question raised is just what phases of brake standardization are to be discussed? Since there was no definite proposal concerning what was to be discussed it made it rather difficult to prepare any discussion of this subject. To make it still more difficult, there is very little data available on the new 600 series motors. Complete data either electrical or mechanical has not been available on these new motors.

Because of the above difficulties we thought it best to merely review the application of brakes, mention some of the problems encountered in the application of brakes to the new 600 series motors and to ask questions.

In the early reports that were published on the new 600 series motors we were led to believe that horsepower, speeds and torque ratings, for all practical purposes, would be essentially the same as the old 400 series. The only difference being that for the same horsepower the new 600 motors would be one frame size smaller. Later data indicated that this was essentially so, however for some reason or other, it was decided to omit the ½ hour ratings on the new 600 series motors. This immediately raises the question how are these new motors going to be applied on crane service? Are you going to apply these motors on cranes for the horsepower and torque on a one hour basis, or are you going to take advantage of the higher torque and horsepower when applied on a shorter duty cycle? This is a very important point since it will affect the choice of control, resistors and brake coils. It is my belief that it will be necessary to have a rating on these motors for such applications either on the basis of a ½ hour rating or some application factor will have to be established which can be used when the motors are used on cranes. Otherwise the crane builder, the control manufacturer, and the mill men may all be applying their own factors which will not be the same and may cause confusion.

We have had orders come into our plant for brakes on these motors some of which have been applied to cranes on the 1 hour basis, some on the old ½ hour basis and some for oversize brakes for motors on which we did not know just what hp rating was to be used.

Without a ½ hour rating or some application factor that will be used universally, considerable misunderstanding may take place between the purchaser and supplier of control for any given application.

For example let us assume that a frame 610 motor is being used on a crane and that control is being supplied from a purchase order that calls for control for a 610 motor rated at 50 hp, one hour, however the purchaser has applied this motor to a crane that requires 65 hp on the old ½ hour basis. Upon receiving the control the purchaser will find that his resistors are not right, they do not have the correct resistance steps or capacity, the contactors are too small, and the brake may have a coil that will burn out.

The lack of a common understanding of the application of motors can lead only to confusion and a lot of wasted effort in checking interpretations of all applications.

In any attempt to determine the different sizes of brakes for any standard it is my belief that the following factors should be considered:

1. Minimum number of brakes required to cover all motors concerned. We are not only concerned with the use of brakes on mill motors, but also on industrial type motors both a-c and d-c. Even in steel mills the use of industrial motors is beoming more of a factor every day on such applications as processing lines, a-c cranes, etc.
2. The most economical distribution of these sizes when compared to usage factors of the different motors. It is possible that because of a high usage factor on certain motor sizes that economy would result from having brakes which cover fewer sizes of motors or at times may only be applied to one motor size.

Standard torque ratings on series brakes as now set up by NEMA are as follows:

1 hour	½ hour
60	90
135	200
350	525
600	900
1200	1800
2400	3600

TABLE I

Brake Application Table

Frame sizes		Hp ratings				Series motor torque rating				Nema brake ratings				Brake coil application 230 v				Use factor	Use factor	
		1 Hr hp rating		½ Hr hp rating		1 Hr torque ratings		½ Hr torque ratings		400		600		Series A 600		Series B 600		Mill motors	Brake used on mill and industrial motors	
400 Series	600 Series	400 Series	600 Series	400 Series	600 Series	400 Series	600 Series	400 Series	600 Series	1 Hr	½ Hr	1 Hr	½ Hr	1 Hr	½ Hr	1 Hr	½ Hr		Mill	Industrial
402	601	5	5	6½	6½	29	29	46	46	60	90	60	90	C85	C85			8.5	25%	75%
403	602	7½	7½	10	10	49	49	81	81	60	90	60	90	C86	C86			8.1		
404	603	10	10	13½	13½	72	72	116	116	135	200	135	200	C104	C104	C105	C105	8.2	38%	62%
406	604	15	15	19	19	121	121	178	178	135	200	135	200	C106	C106	C107	C107	12.0		
408	606	25	25	33	33	228	228	350	346	350	525	350	525	C142	C142	C145	C146*	15.2	53%	47%
410	608	35	35	45	45	350	350	515	514	350	525	350	525	C144	C144	C147	C147	18.1		
412	610	50	50	65	65	525	525	775	776	600	900	600	900	C185	C185	C184	C185*	16.3	52%	48%
414	612	75	75	100	100	830	830	1250	1250	1200	1800	1200	1800	C217	C217	C213	C213	7.2	95%	5%
416	614	100	100	135	135	1140	1140	1730	1730	1200	1800	1200	1800	C218	C218	C213	C213	3.2		
418	616	150	150	200	200	1750	1750	2630	2630	2400	3600	2400	3600	C271	C271	C264	C264	3.2	95%	5%
	618	x	x		x		2560		3980										Total 54%	46%

These brakes covered the old 400 series motor frames from 402 to 418 and will now cover the new 600 series from 601 to 616. This covers all of the present 600 series with the exception of the contemplated 618 rated at 200 hp, 1 hour.

In the application of these series brakes, coils must be selected that will enable the brake to deliver the rated torque of the motor, release the brake with only 40 per cent of the motor full load current and remain released down to 10 per cent of the motor full load current.

In checking brake coils used on the above line of standard brakes when applied to mill motors, it was found that in almost all cases the same coil in the brake will cover both the 1 hour rating and the ½ hour rating of the motor as long as the motor is being used to handle its nominal rating. However, there are applications which are over-motored, and control is built to meet load conditions and speed requirements and such cases will require a careful selection of coils on brakes in order to meet the torque and motor loads encountered.

Mechanical difficulties encountered have been due to two reasons:

1. On five of the new motors it meant mounting a larger brake on the same frame size motor. In some cases this has meant that the brake base would be below the motor base instead of being on the same plane or above it. This point should always be checked with the brake supplier.
2. Because of the lack of complete dimensions of bearing housing, bolt bosses and other projection on the ends of the motors, it is necessary to guess or estimate these dimensions in order to locate the brake so that it will clear the motor. In many cases the result has been hub extensions on wheels which are longer than is necessary, and this has caused not only a waste of space, but also embarrassment when the user has installed the motor and brake.

However, steps are being taken by the manufacturers of the motors to supply those concerned with the necessary dimensions in order to overcome this second difficulty.

Table I is a brake application table. The use factors for brakes on mill and industrial motors which is the experience of our company is given in this table. They represent only our experience ratios and not those of the entire industry.

The use factors for mill motors indicated on Table I were taken from the discussion of mill motor standards by Mr. Frank W. Cramer published in *Iron and Steel Engineer*, March 1947.

Under brake coil application under Series B, two coils have asterisks indicated opposite them and these identify coils which would be different for the 1 hour and ½ hour rating in this particular series of brakes. However after investigating these coils we feel that it is possible to design the same coil for 1 and ½ hr duty service for these particular frame sizes, so that the brake coil application would not be affected by the duty rating of the motor.

Under NEMA brake ratings for the 400 and 600 series motors vertical lines are drawn between some of the 400 and 600 series motor column. These indicate those frames in the 600 series motors which will require larger brakes due to the increased hp ratings, for example frame 603, although it has the same physical dimensions as the old series 403 motors, will now require a 135 ft lb rated brake instead of a 60 ft lb torque rated brake for 1 hour service. In other words these lines indicate those 600 series motors which will require a larger brake.

EFFECT OF WR² ON BRAKE DESIGN

By A. E. LILLQUIST, Supervising Engineer,
Cutler-Hammer, Inc., Milwaukee, Wisconsin

▲ A few comments regarding brake wheels and WR² may be of interest. As mentioned by Mr. Cortelli, brake wheels used with mill motors usually have offset hubs to locate the center line of the brake far enough away from the motor to insure that there will be no interference between the brake and motor frames. In general, it is desirable to keep the brake as close to the motor as possible without physical interference. Unfortunately, the standard motor dimension drawings now available do not have enough detail of the motor end frame dimensions to permit layouts to provide a minimum clearance. That means that the brake manufacturer must do considerable guessing, with the result that larger offsets may be used than are actually required.

As also stated, the mill motor manufacturers have recognized this problem and plan to furnish brake manufacturers with more detailed dimensions of their MD600 motors. However, until we have that information, we are still guessing.

We now receive orders for brakes for these new MD600 motors. We lay out a brake with a particular motor to determine the wheel offset. If the motor is a General Electric frame, our layout covers that frame only; if it is a Westinghouse motor, the layout covers that motor only. On the other hand, if we have dimensions in the particular frame size for both manufacturers' designs, then our layout will show the wheel offset necessary to clear both makes of motors. That means we set up temporary wheel offset standards. We send the crane builder a brake dimension drawing showing the wheel offset for a specific frame size, and he proceeds with his designs. Later on, we may find it necessary to make changes because another motor manufacturer has entered the field and the contour of the end frame of his motor may not be the same as that of the MD600 motor for which we previously received dimensions from other manufacturers.

Obviously, changes in hub offsets would handicap not only to the brake manufacturer but also the mills and the crane builders. I recall in the case of the preceding line of mill motors that some of you objected strenuously to the fact that after we made standard dimension drawings of brakes with offset hubs, we found it necessary to make changes because another

motor manufacturer brought out his line of mill motors. I bring this point up because we are going to be in the same position again and I am afraid we will have objections from brake users, but there is nothing that we can do about it until the standards of all mill motor manufacturers have been settled, and we have detailed information on the contour of the end of the motor frames.

WR^2 is always of interest to a brake engineer. I am afraid that sometimes our salesmen feel that the engineer is helpless and hopeless without WR^2 and a slide rule. Be that as it may, WR^2 and speed determine the energy in the rotating system, and the energy in the rotating system determines to a large extent the work to be done by electrical and magnetic braking. WR^2, then, can be used as a guide to a brake wheel heating and lining wear when a new line of motors replaces an old line. If the WR^2 of the brake wheel plus the WR^2 of the motor of a specific horsepower is the same in the new line as in the old, then we are quite safe in assuming that the lining wear and the brake wheel heating will be the same.

As far as the brakes are concerned, the same brake will be used in the MD600 series as was used in the old line for corresponding horsepowers; not for corresponding frame sizes. Since the same size of brake is used, the same WR^2 of wheel will apply. I recently saw a tabulation of the WR^2 of the new line of MD600 motors as built by one manufacturer. The WR^2 for the frames had increased appreciably when comparing the same motor physical dimensions, but for the same horsepower rating in the new and old frames, the WR^2 was approximately the same. For example, for the 35 hp No. 10 frame, the WR^2 was 40.2, while for the new MD610 motor having the same dimensions, it was 72. However, the MD610 motor is rated 50 hp, not 35 hp. For the old No. 12 frame, also rated 50 hp, WR^2 was 69.5. Thus, for the same horsepower rating, the MD600 series motor had a WR^2 of 72, and the old line motor had a WR^2 of 69.5. A similar relationship held throughout the range of new and old motor frames. Therefore, for the same horsepower rating, the WR^2 of the brake wheel plus the motor will be about the same for both the new and the old lines of mill motors. That means that the work to be done by electrical and magnetic braking will be about the same in both cases. The heating and wear of brake wheels and linings should, then, be approximately the same. The tabulation of motor WR^2, which I referred to earlier, was for motors made by one manufacturer. I wish to make that point clear, because it has been mentioned that the WR^2 of the MD600 motors was less than that of the old line of mill motors.

I mentioned speed in this discussion of wheel heating and lining wear, and stated that it was a factor in determining the energy in the rotating system. The full load speeds of the MD600 motors are the same as that of the old line of motors of corresponding horsepowers. However, as pointed out by Mr. Cramer in his report to the convention in 1946, motor speeds at light loads will be higher in the MD600 line than was the case with the old line mill motors. That will have some effect on the work to be done by electrical and magnetic braking, because of the higher kinetic energy at the light loads. The change in light load speeds is not very great, and it would be difficult to generalize on the subject. We will have to wait to see what experience shows.

I do believe, however, that it is safe to assume that the brake wheel heating and lining wear on brakes used with the MD600 line of motors will be the same as the heating and wear on the brakes used on the old line of motors.

DISCUSSION

PRESENTED BY

F. W. CRAMER, Electrical Engineer, Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania

L. A. UMANSKY, Industrial Engineering Divisions, General Electric Company, Schenectady, New York

L. R. MILBURN, Electrical Engineer, Great Lakes Steel Corporation, Ecorse, Michigan (now a consulting engineer, Detroit, Michigan)

M. A. de FERRANTI, Industrial Engineering Divisions, General Electric Company, Schenectady, New York

JOHN D. LEITCH, Chief Engineer, Electric Controller and Manufacturing Company, Cleveland, Ohio

V. E. SCHLOSSBERG, Superintendent, Electric, Power and Steam Departments, Inland Steel Company, East Chicago, Indiana

F. W. Cramer: One of the basic things that will have to be decided is what we are going to call this new motor, whether we go by 60-minute horsepower or the 5-hour rating, or the frame size, or whether we follow the curves. Last year Mr. Umansky of General Electric gave us a very interesting talk on naming this new motor.

L. A. Umansky: Let us agree, first of all, that the so-called 30-minute or 60-minute motor ratings were ill-chosen originally and have no physical or practical meaning. No one actually expects to take, for instance, a motor frame 610, impose on it a steady load of 65 hp for 30 minutes, or a steady load of 50 hp for 60 minutes, and then wait for the motor to cool off before imposing the load again. Actually these mill motors, whether used on cranes or on auxiliary drives, carry intermittent load cycles, with load periods, always lasting less than 5 minutes, and alternating with rest periods. The higher the load, the longer should be the rest periods, or — to put it differently — the shorter should be the "time-on" period, so as to end up with the same average heating or rms value.

For instance, the 610 motor, if totally enclosed and non-ventilated, can carry an average heating load of 65 hp for short periods comprising about 14 per cent

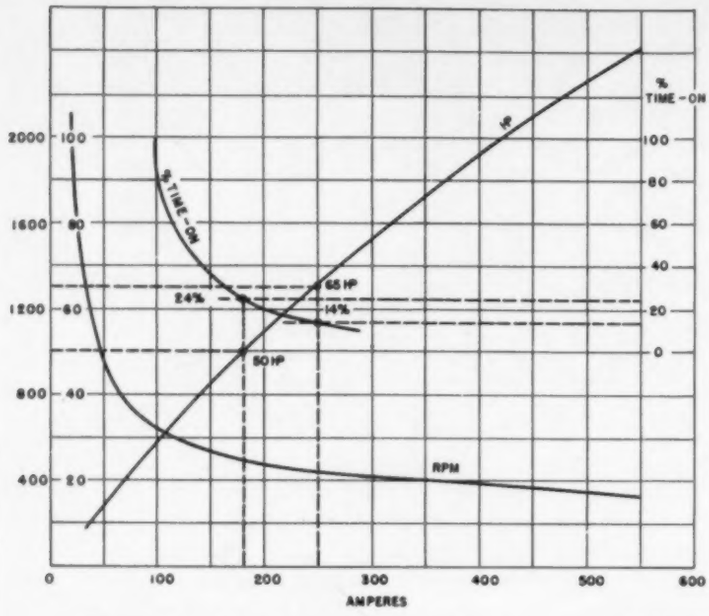


Figure 1 — Approximate performance curves for MD610, 50 hp (60 min), 500 rpm, 230 volt, series wound mill type motor.

of total time; or similar 50 hp short-time loads for about 24 per cent of total time.

This information is usually given by curve sheets, like Figure 1, and is available for the new line of mill motors.

While the duty on many cranes has a rather low "per cent time-on," it is wrong to generalize this point. Motors on a soaking pit crane, or a stripping crane, have a greater "time-on," and are working harder than the motors on, say, some mill approach tables or some crop shears.

Thus, as far as heating is concerned there is no sound reason why a single "name" or rating should not be assigned to a given motor frame, regardless of its application, just as the AISE committee has recommended. The name itself (i.e. the "60-minute rating") is still meaningless, but at least with one name there should be less confusion all around.

As a temporary expedient, a table should be made available tying together the 60-minute and the would-be 30-minute ratings of the new 600-series motors. This should help all those connected with crane applications where the 30-minute ratings were prevailing heretofore. After a year or so everyone will get used to the 60-minute ratings, and everyone will be using only one name for a given motor size.

The peak load capacity of a given motor, expressed in maximum amperes which it will successfully commutate, is of course the same regardless of the heating rating stamped on the nameplate.

If we take two duplicate motors, one installed on a crane, and another on a mill auxiliary drive, it is logical to expect that the ampere ratings of their control panels should be identical in either case, because the permissible motor rms loads and peak loads are the same, respectively. The two panels do not have to be, of course, interchangeable since the circuits are apt to be different. Likewise, the resistor classification is not necessarily identical, since it might be different even for various cranes or for various auxiliary drives, depending on duty cycle. But it is difficult to make a strong case for the present practice of using some times different contactor sizes for identical motors just because one machine might be called, say, 50 hp, 60 minutes, and the other — 65 hp, 30 minutes. I may call our today's chairman either Frank, or Mr. Cramer, but this does not change the size of the suit which he should wear.

L. R. Milburn: In speaking of brakes, I think the thing we are trying to get across is that we should have standard brake wheels. One manufacturer makes a 9½-in. brake wheel with a 5-in. face. Another manufacturer makes a 10-in. wheel. Maybe the next fellow will have an 11-in. wheel. The rating of that brake for all three or four manufacturers is practically the same, but if I have a motor with a 10-in. wheel on it, I cannot put an armature in that motor with a 9½-in. brake wheel on it, and I think that is what we want in the steel industry, a standardization of wheels and centerlines.

The horsepower or the torque rating of the brake will then equalize itself. I do not know any other way to express it, but that is a thing I ran into in the last week, in which a crane manufacturer sent me a crane, and he had a 9-in. wheel on it but I had no 9-in. wheels in the plant. I then had to wait a week until the manufacturer could make his brake and send it to me. If we can standardize on the wheel and on the centerline dimensions of the brake, I think then we will have accomplished something.

Marc de Ferranti: There are two points which the representatives of brake manufacturers have mentioned on which I would like to comment. The first one concerns the confusion due to the application on cranes of the one-hour rated motor instead of (as formerly) the ½-hour rating. This is being dealt with by the group concerned with crane specifications, and it is the intention to establish formulae which will clearly indicate the items to be considered when applying the new motor.

The second item I want to mention is the one concerning dimensions of the MD motors and the MC motors which affect the brake mounting. We, as motor manufacturers, recognize that such information is very important to the brake manufacturers, and we are already canvassing the manufacturers of all brakes to indicate to us all of those contour dimensions of the new mill motors which affect their brake mounting. We will then make available tabulated drawings showing all those motor dimensions which affect brake mounting.

John D. Leitch: I would like to say a word or two regarding brakes, series brakes in particular, and their application to d-c motors. I have examined the thermal ratings of a number of our series brake coils, and I am sure that other manufacturers of brakes will find the same thing I did if they examine theirs. If a series brake coil is selected having a given 1 hr current rating corresponding to the 1 hr horsepower rating of a particular motor, it will be found that the ½ hr current rating of the same coil will correspond very closely to the ½ hr rating of the same motor. There is, therefore, no problem in the selection of series coils for brakes.

The reason for this is that the thermal capacity of brake coils is comparable to that of the motors with which they are used.

It is in the matter of control that I might express an opinion different from that of Mr. Umansky. Contactors and resistors are chosen usually on some intermittent rating according to the application. For the same temperature rise, it is obvious that a motor used at its ½ hr ability will have to be operated on a less severe duty cycle than if it were used at its 1 hr ability. In other words, the rms of the load cycle must be held to approximately the same value for the same temperature rise.

Contactors and resistors have in general lower thermal capacities than the motors with which they are used, consequently their ½ hr and 1 hr abilities or thermal ratings are not in the same proportion as those of the motors. Thus in selecting contactors and resistors we must know the actual rating at which the motor will be operated as well as the overall duty cycle if we are to keep within specified temperature limits.

It is customary in steel mill practice to give contactors an intermittent rating of 133 per cent of their continuous rating, and to so select them that this intermittent rating will not be exceeded by the full load current of the motor at either its ½ hr or 1 hr ratings according to which is used. In other words, if I recall some figures correctly, a certain motor has a 35-hp, 1 hr rating and a 45-hp, ½ hr rating. Contactors selected for the control of such a motor might have 100 or 150 ampere continuous capacity according to the rating at which the motor will actually be operated. A similar dividing line occurs at the motor size having a 50-hp, 1 hr rating and 65-hp, ½ hr rating where it is necessary to change from 150 ampere contactors to 300 ampere contactors there being no intermediate NEMA standard sizes.

V. E. Schlossberg: Back about 1926 we had a steel plant built for a certain tonnage although the plant was producing far greater tonnage. We had some MC 50 motors which were doing jobs far greater than an MC 50 motor should be expected to do, which, if I recall correctly, was rated 30-hp on the 1-hour rating and 37-hp on the ½-hour rating. As this motor was doing a terrific job it resulted in the motors being changed quite often, in fact in less than a month's time. To eliminate these changes we installed a MC 60, which has a rating of 50/65-hp and this motor went on with almost indefinite life. This was the case of applying what we are now proposing to do today, namely, the next larger frame size motor on overloaded drives and eliminating our maintenance problem.

We had the same thing on resistors although the resistor problem was not always associated with the overloaded motor. We had resistors which were fair, and motors which would not respond fast enough to the resistor. Back in about 1927 we began standardizing our resistors and found that for the greatest resistor life we could apply the same resistor on a crane that we could on a mill motor. It was true that they punished the motor more, if you want to call it punishment; as we gave the motor a higher inrush thus starting the motor sooner. At the same time, this eliminated one of our brake problems on hoists, because it gave the motor a greater inrush current under light loads.

As a result of this study, we have in our crane specifications a standardized resistor layout. The control builders do not like it. However, we have found in our plant that it works very satisfactorily and gives us practically an indefinite resistor life, although it does give a greater current inrush on your mill motor rating.

What we are endeavoring to tell you is that back as far as 1927, we have used this idea of applying motors on the 1-hour rating by changing from one size motor to the next larger size. We definitely found that if you apply the resistor and brake on the 1-hour rating, you will have a very satisfactory operating unit. However, you will meet resistance from the mechanical men because as you apply a motor on the 1-hour rating, it lowers the mechanical strength of their design, providing they apply the design on that rating. In other words getting back to the crane, if you use a 50-hp 1-hour rating and tell the crane builder that is a 50-hp motor, he feels for his self-protection he has to design that particular unit based on a 50-hp rating, whereas previously he was allowed to design it on a 65-hp, ½-hour rating, that would tend to lower the price which he can charge for the unit.

You will have a great deal of difficulty on this score. However, we can tell you that where we have taken a 50-hp, ½-hour rating motor off a crane due to short motor life and have applied the next larger rating calling it a 50-hp, 1-hour rating there has been less mechanical maintenance on the crane than there was with the smaller motor. Of course you realize the motor applied was 65-hp, ½-hour rating.

There is one more point I would like to mention here and that is brake wheels. A number of years ago we surveyed our MC, MD and K line of motors which used brakes, and adopted as a standard the maximum hub extension which would be required so that for a given brake wheel diameter, a common hub extension is used on any motor requiring a brake wheel of this diameter. We have been ordering these brake wheels for a good number of years with this fixed hub extension, which allows you to apply them on either the MC old line 70's, 60's, etc., the new line MC motors, the 181's, the new line MD 400 motors, and the K type motors. Of course, you can come back and say they all have different bores. That is true. However, if you need a brake wheel fast, you can always send it to the shop and have the bore turned out. The hub extensions are all the same.

New Techniques in Conditioning Stainless Steel

. . . . mechanical machines which have been developed for grinding slabs and strip offer possibilities for better quality and production at lower costs . . . .

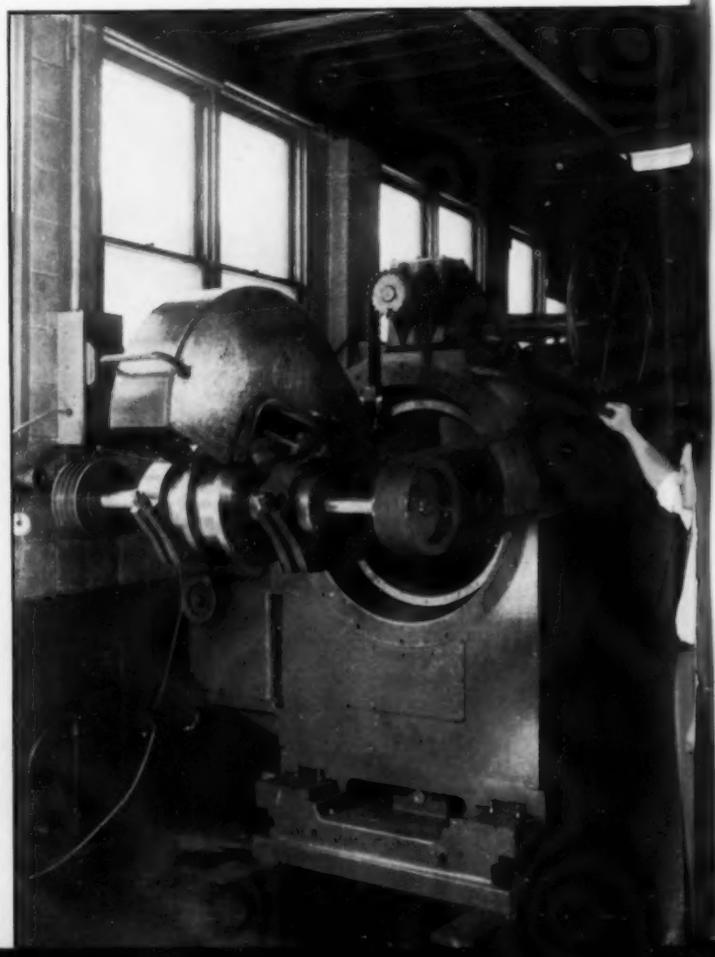
By A. E. HAMILTON, JR.
Vice President
Hamilton Pump Company, Inc.
Pittsburgh, Pennsylvania

▲ EMPHASIS today is more and more on superior finishes on all types of metals, but especially those used in decorative fabrication. Stainless steels of all types fall into this category. The finish quality of such steel depends largely on its fundamental and successive conditioning. In fact, the people of our organization have reached the conclusive theory that sensitive stainless and high alloy steels, melted and poured with such determined care, must receive more and more nurtured and delicate treatment in each evolved stage of conditioning, from the bloom to the finished product. The molecular structure of such steel is extremely select, each molecule is ultra-discriminatory about its position in the mass, and any brutal disturbance of this selected position results in metallurgical difficulties. Since such steels could almost be considered akin to precious metals, it is fitting that they be treated as carefully as such. The artisan watchmaker, after months of careful expert construction of his timepiece, does not at the end pound the enclosing case on with a sledge hammer. Neither should our higher grade steels be subjected to brutually harsh conditioning operations.

Reference to the term "conditioning" in this report is confined to scale and defect removal on stainless hot rolled products (blooms, billets, slabs, plates and sheet bars), and the required abrading (including both intermediate grinding and final finishing) of cold rolled steel strip and sheet. This paper, therefore, divides itself into two logical categories, and will present:

Presented before AISE Annual Convention, Pittsburgh, Pennsylvania, September 22, 1947

Figure 1 — A biforcated arm holds the spindle on which the slab grinder's grinding wheels are mounted.



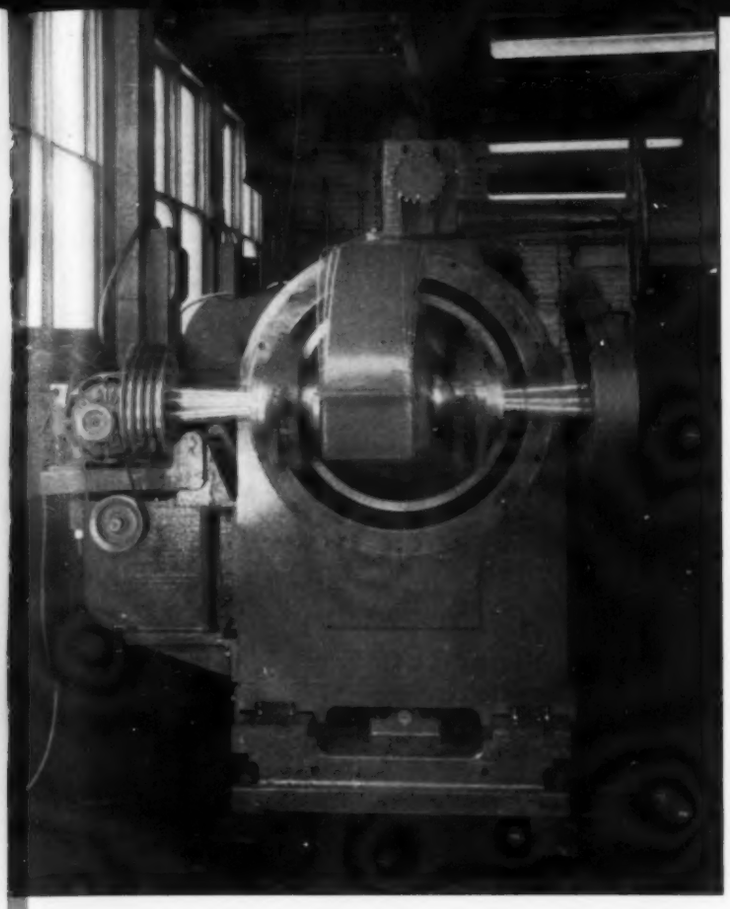


Figure 2 — There is both oscillatory and vibratory motion on the grinder when in operation.

1. Design features and purposes of a new machine for automatic liquid conditioning of blooms, billets, slabs, plates and sheet bar.
2. Design features and purposes of a new machine for liquid conditioning (more specifically grinding and finishing) of strip and sheet.

Both machines, through radical design departures, consistent with our philosophy of careful conditioning of sensitive steels incorporate the means for new techniques in the two fields mentioned.

SLAB GRINDER

The first machine is known commercially as the slab grinder. The infant or development model only is in production, grinding at this time the flat surfaces of steel slabs up to 30 ft long, 24 in. wide, and 4 in. thick. Plans for the design of this machine began at the end of the war, when we agreed with a customer associate of ours that the main technique used today, manual swing frame grinding, was more or less inhumane, unhealthy and uncontrollable due to a multitude of human elements. The operating objective of this machine, therefore, was single in purpose — to do mechanically and electrically what had hitherto been done manually. Design thought was given (but only secondarily) to the important factors of operating cost and production speed which, even without important refinements now in process, are well within economic limits.

Figure 1 is an angle view of the head only while on skids prior to installation. Note the biforcated arm mounted on trunnions in the main housing and protruding forward to grip the spindle on symmetrical bearing cages. The wheel hood guard is partly raised to reveal the flanges for mounting a 30 × 4 × 12 standard snagging wheel. Only one set of drive belts is shown although belts on both sheaves are driven by a double shaft 50 hp, 230 volt, d-c motor, mounted on the rear of the biforcated swing arm. The swing arm moves vertically on trunnions and is operated by an 8 in. diameter air cylinder mounted internally on the main base within the housing. Working pressure is controlled by master and sensitive air regulators and gage, while finer adjustment is obtained by the hand wheel and swing arm chain at the top. Hardened ways and ball races provide for reciprocation of the head transversely across the work which is conveyed at controlled speeds by table under the grinding wheel. Reciprocation is accomplished by a 5 hp, d-c, reversing motor and gear train mounted in the housing, actuating a screw and bronze nut (shown here on the base under the main housing) and electrically governed by reversing controls with dynamic braking. Figure 2 shows a front panoramic view of the oscillatory movement of the swing arm which not only moves vertically on trunnions, but also radially transcribes a limited arc on the circular ball race in the center of the main housing. This movement is called oscillatory and lesser vibratory and is transmitted by link connection from the gear case shown at the left. Drive is from the 5 hp, d-c, nonreversing motor mounted above the gear case, and the unique movement derives from the hypocycloidal evolution generated by planetary gear arrangement in the oil filled gear case. This movement, when combined with the transverse reciprocation of the head itself, and the intermittent travel of the conveyor, imparts a superhypocycloidal evolution pattern which never repeats itself. This device expressly simulates the human shoulder and body movement of the man who laboriously operates the swing-frame grinder. A manual operator is shown in Figure 3, and is a picture familiar to all. The oscillatory movement of the swing arm serves two important purposes:

Figure 3 — Manual swing grinding requires constant, hard work on the part of the operator.

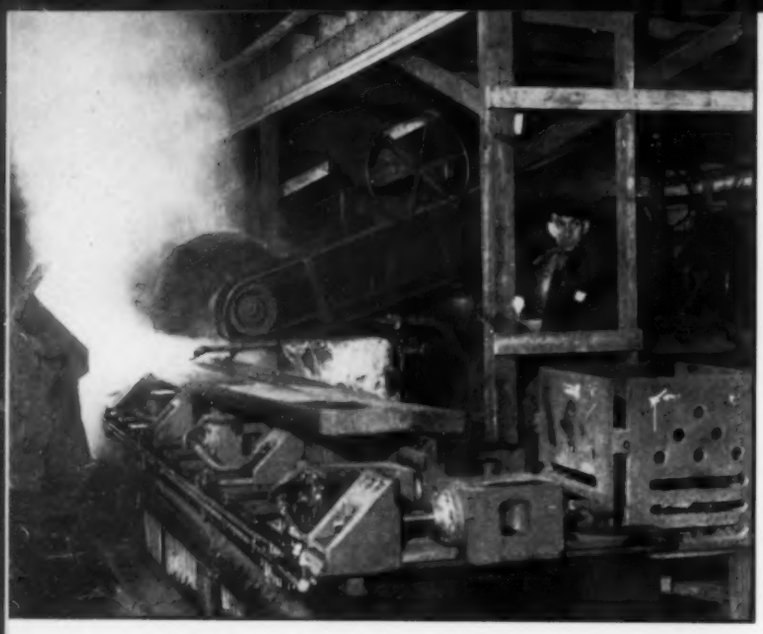


Figure 4 — The automatic grinder relieves the operator of the heavy work, resulting in a more uniform product.

1. It permits deep snagging and metal removal when required and so regulated.
2. It keeps abrasive grain constantly sharpened and resharpened, and prohibits wheel "loading."

Figure 4 shows the slab grinding machine in operation grinding two surfaces at once of straight chrome steel slabs 9 × 3 in. × 30 ft long while the operator stands by. All grinding is done under water as can be seen from the atomized spray. Water is applied at controlled pressure and volume directly into the face of the wheel from under the swing arm and at the sides of the wheel by spray nozzles. All cuttings and dust are smothered and washed into the front splash guard and removed in the lower tote box periodically. The conveyor is driven by a 10 hp, d-c, motor with gear reducer and gear train and is electrically synchronized with the variable cross-grind stroke of the head. Either regular (constant) or intermittent travel of the conveyor enables speeds varying from 3 in. per minute to 3 ft per minute. Slabs are gripped rigidly by special air vises which can also be used for turning slabs.

Figure 5 shows a diagramatic view of the operator's pulpit table and serves to illustrate the maneuverability of this machine by finger tip control. Operating controls, by the numbers, are as follows:

1. Hand wheel for fine vertical adjustment of wheel.
2. Valve for adjusting flow of water.
3. 4-way valve for lowering and raising wheel.
4. Master regulator (safety load for wheel pressure).
5. Sensitive hand regulator and gage for varying wheel pressure during operation.
6. Blinking safety light to indicate intermittent conveyor travel.
7. Pushbutton to actuate cross grind stroke.
8. Rheostat to vary speed of cross grind stroke.
9. Pushbutton to actuate wheel revolution.
10. Pushbutton to actuate oscillation.
11. Rheostat to vary speed of oscillation.
12. Pushbutton to actuate water pumps.
13. Pushbutton to actuate conveyor table.
14. Rheostat to vary speed of conveyor travel.
15. Switch to control intermittent versus regular conveyor travel.
16. Switch to determine direction of conveyor travel.
17. Hand wheels for quick adjustment of both left and right travel of cross grind stroke.

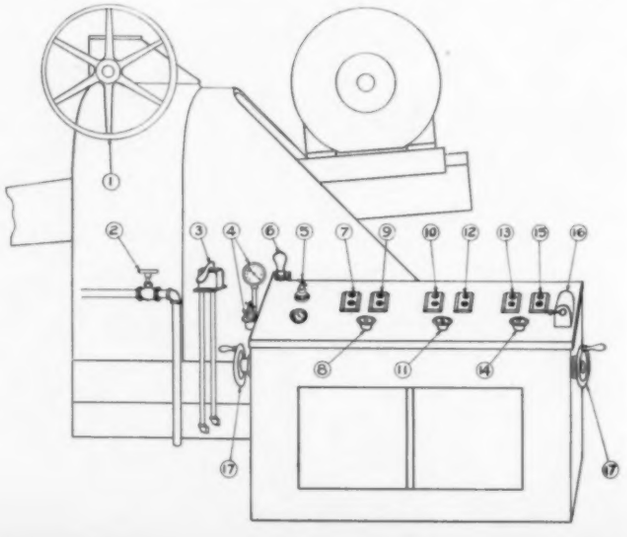
In addition, but not shown are:

1. Automatic rheostat controls for increased wheel rpm as wheel wears down in diameter so that optimum grinding surface speed can be maintained at all times.
2. Hand wheel control for adjustment in degree of oscillation extremity.

We have covered the principal design features of this equipment, and now we will cover the new techniques and accomplishments which are provided by this automatic slab grinder.

1. *Removal of the human element* — Operating men are well familiar with the many uncontrollable human variables in manual grinding. These variables cannot scientifically be compensated for in the matter of observation for operating intelligence. For instance, no two manual operators grind exactly alike. One may reduce a wheel in four hours, another in twenty hours; one may produce two tons, another, six tons, in varying lengths of time even though condition of the steel is comparable; one man may weigh 210 pounds, the other man, 130 pounds, and each may be accustomed to applying varying weights on his grinder. Certainly each operator has his own special techniques for grinding which may or may not tend to permit excessive abrasive wear. Fatigue, too, is an important factor. One operator will grind differently at 3 pm than he will at 8 am, which in turn may vary greatly on his previous night's activities. In addition, there is the down time for

Figure 5 — Diagrammatic view of operator's pulpit.



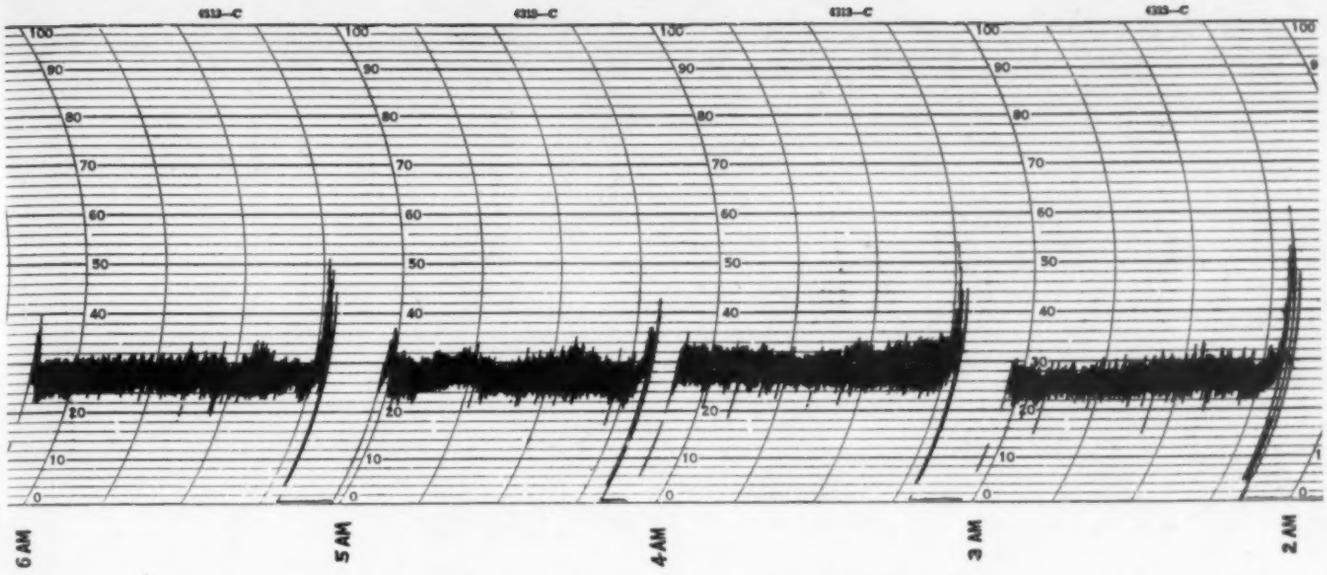


Figure 6 — The ammeter chart illustrates the uniformity in the grinding production rate with the machine.

human necessities. A man cannot lay on a swing frame grinder and eat his lunch at the same time. Health and safety are perhaps the most important of all factors. The manual grinder retards his pending silicosis or pneumoconiosis only by the constant discomfort of tight goggles and stifling respirators. His backaches, muscle pains and strained stomach tissues he must take in his stride. A broken leg or blinded eye from broken wheel fragments is not easy to take. These disturbing human elements and unhealthy conditions are eliminated for the operator of this automatic slab grinder. By complete finger tip control he can set his machine for desired speeds, feeds, and metal removal and, while he is sitting by eating his lunch, his steel is being conditioned and the water is smothering the grinding dust. In eight months of constant operation, we have experienced two wheel breakages. In both cases, although the impact was so strong as to stall the 50 hp motor, all fragments fell directly into the water trough beneath the wheel without the slightest hazard to any personnel. The best way to emphasize the absence of human element and at the same time the present possibilities for operational control through this new technique is shown in Figure 6. Here is part of an ammeter recorder chart which constantly plots the minute by minute operation of the machine through the action of the grinding wheel. The chart is graduated vertically by ampere load on the wheel and horizontally by minutes and hours. An operational foreman thus keeps his 8-hour turn or 24-hour day production record completely and totally on this chart with indisputable evidence as to:

a. Contact time.
b. Down time and reasons.
c. Tons conditioned.
d. Heat numbers, bar numbers, type steel and bar weights.
e. Metal removed.
f. Type and amount of abrasive wheel used.
g. Power consumed.
h. Operator's check number or name.

In fact, there is no information for production or statistical purposes that cannot be read into these charts. This illustration happens to record four passes covering eight surfaces of two double slab setups — approximate weight 10,800 pounds; actual contact time 215 minutes, or 0.66 hours per ton surface grinding. Complete running time here, including non-contact time for loading and turning slabs, equals 239 minutes or 0.737 hours per ton.

2. *Benefits of wet grinding* — To date water only has been applied as described earlier. The water smothers the injurious grinding dust thus providing cleaner, healthier conditions without the costly expenditures for dust removing blower systems. In addition, water keeps the wheel cool and prolongs wheel life. The breakdown of the wheel is now largely accomplished in a different manner, the excessive heat generated by the controlled increased grinding pressure is dissipated by the application of water, and the abrasive bond is not melted to a point where it prematurely liberates abrasive grit. At the same time the wheel face is washed free from redeposited loading and, of course, is constantly submitted to the cleaning action of the non-repetitive hypocycloidal motion.

More important still is the fact that wet grinding keeps the steel cool while being conditioned. In the case of 18-8 nickel-chrome steel, cool grinding reduces the tendency of the metal to distort. Cool grinding is even more vital in the case of straight chrome stainless steel. In current manual methods the heat generated by dry grinding tends to open up chrome checks or cracks, causing them to spread and grow deeper. Because of this fugitive behavior, such defects are completely removed only when the hot grinding wheel "catches up to and heads off" their spreading action. Needless to say, much expensive steel, as well as abrasive grit, is ground away during this race between the hot steel and the defects. This problem is minimized under wet grinding conditions. With the automatic grinder the wheel can be positioned on a surface crack and will whisk out the lengthy seam at full speed. The steel and wheel being cool, there is no deepening or widening of the seam unless it is an oxidized crack running deep into the thickness of the slab.

3. *Wheel economy* — Currently 30 in. diameter × 4 in. face × 12 in. bore aluminum oxide wheels are used although design will accommodate larger sizes, and No. 12 grain in resinoid bond with a U grade hardness is most desirable. Rubber wheels have also proven satisfactory both for surface finish and life. The water, of course, permits use of rubber without any of the disagreeable odor. Due to crude rubber shortage, however, these wheels have been limited to No. 20 grain with R grade hardness. The water and oscillatory motion keep the wheel clean and free-cutting, even when extremely heavy working pressures are applied. These pressures, varying from approximately 300 to 500 pounds, are controlled by hand regulator and gage. Production experience has proven highly efficient wheel performance, ranging up to a ratio of 8.65 (lb metal removed) to 1 (lb abrasive loss). In terms of cost for example: if 2½ per cent metal removal were required, abrasive cost per ton would be $2.47, or less than $0.05 per pound of metal removed. This would be less than half the known abrasive cost of some mills. Abrasive engineers of various wheel manufacturers are digesting this application and feel confident of better performance with progressive development.

4. *Production performance* — Although this original machine was designed specifically to take the human elements out of slab conditioning, economic operation was not overlooked. In fact, even initial experiments proved well within competitive range. As illustrated by the ammeter recorder chart in Figure 6, running time on surfaces of normal slab sizes amounts to 0.74 hours per ton. This compares to a generalized 3-man hours per ton under manual operations, or, roughly, one-fourth the production time. It is important to note that where the many human elements (fatigue, personal idleness, etc.) in swing frame grinding necessitate exorbitant down-time, the automatic grinder, involving predetermined mechanical machine cycle operations, enables this wasteful down-time to be kept to an absolute minimum and without hardship on the worker. In short, this automatic equipment makes possible conversion of snagging into a streamlined continuous operation.

In the past there have been several other attempts to design automatic grinders for billets and slabs. These attempts have not progressed due to the fact that machine operation was relatively static and uncontrollable with respect to surface removal. Since there was no compensation for hoops, bows and edge cambre, there resulted an excessive metal removal in spots, and inadequate coverage in other surface parts. This automatic slab grinder overcomes such problems by its pneumatic cylinder imparting a resiliency to the swing arm and thus enabling the wheel to "climb contours." At the same time, uniform pressure is applied in grinding all parts of the surface and thus no wheel bouncing. Even slight bouncing of the wheel against the work, as usually observed in manual grinding, can result in impregnated abrasive grain, and frequently "matted" metal after reduction.

Of the various improvements now underway on this equipment, the most important is developed speed. A mechanical change is now in progress which we feel confident will at least double the running speeds, thus reducing grinding time to less than one-half man-hour per ton.

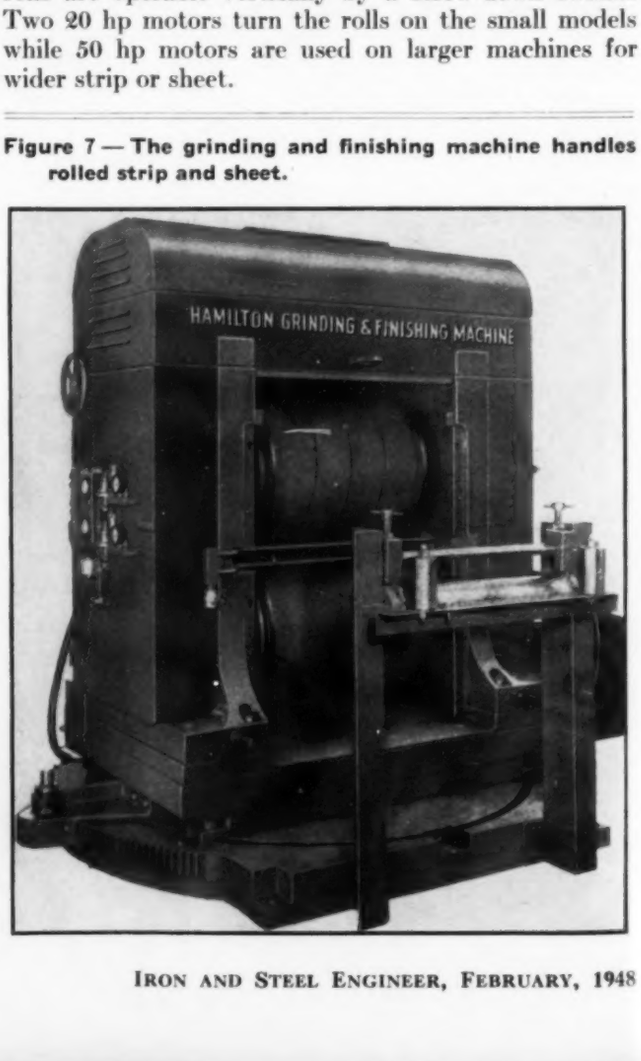
Perhaps the greatest potentiality of the slab grinder can be briefed in this fashion:

1. Removal of the human elements resulting in healthier conditions and more intelligent operational control.
2. Large savings in labor and wheel costs and reduction of the time element in the manufacturing cycle.
3. Controlled metal removal and superior conditioned surfaces resulting in incalculable benefits derived from the probable increase in yield of the finished product.

FINISHING MACHINES

Having described liquid conditioning for hot rolled shapes, the second part of this paper is concerned with new machine techniques for liquid grinding and polishing of cold rolled strip and sheet. This equipment is known as a grinding and finishing machine. The design can be described best when looking at Figure 7. Strip feeds through the machine between the top and bottom rolls, being paid off an uncoiler and taken up on a coiler. The rolls are constructed of steel sections on a shaft with bearing cages mounted in bearing blocks in the vertical housings. A pneumatic rubber drum 24 in. in diameter covers the steel rolls like a sleeve. Finally, coated abrasive coverings, cut on a diagonal from standard abrasive rolls, are wound spirally onto the rubber drums. These coverings are held tight by steel retaining bands after the drum has been inflated. The rolls are operable vertically by a screw-down switch. Two 20 hp motors turn the rolls on the small models while 50 hp motors are used on larger machines for wider strip or sheet.

Figure 7 — The grinding and finishing machine handles rolled strip and sheet.



The equipment is totally enclosed with splash guards so that liquid can be forced at between 80-100 psi pressure into the drum cavities as well as into the combination adjustable pass line roll and scrubbing box. Two 1500 gallon sumps should be provided to supply water, soluble oil or emulsified buffing compound alternately as desired through use of one common pump. As with the automatic slab grinder, oscillation is also provided in these finishing machines but on a horizontal plane parallel to the strip. This imparts an oscillatory and lesser vibratory movement to the entire machine transversely of the strip. In addition, the whole machine moves slowly and transversely on a reciprocating base to desired distances on both sides of the work. Diagonal grinding, a very important feature, is accomplished by a gear tooth swivel base so that the machine can quickly be turned angularly to the longitudinal travel of the work. Figure 8 shows the swivel base at the bottom. This view happens to be of a larger model for strip up to 42 in. wide. It gives a clear picture of the operator's panel and thus provides a good outline for the operating features of the machine. The two sets of pushbuttons at the left actuate the top and bottom rolls. Directly beneath is a manual switch for opening and closing rolls. The ammeters register the ampere load and thus the deepness of grinding cut on each roll. The other pushbutton station operates the hypocycloidal oscillation and reciprocation. To the right are regulators, relief and bleeder valves and air gages for controlling the amount of air pressure in each drum. Located below are enclosed safety air switches which interrupt all electrical circuits if the air in either drum should happen to fall below a pre-calibrated pressure. The large hand wheel is for manual screwdown of the rolls if needed, and the hand valve on the front governs the supply of liquid through the main spray nozzles. This briefly covers the primary design of this equipment.

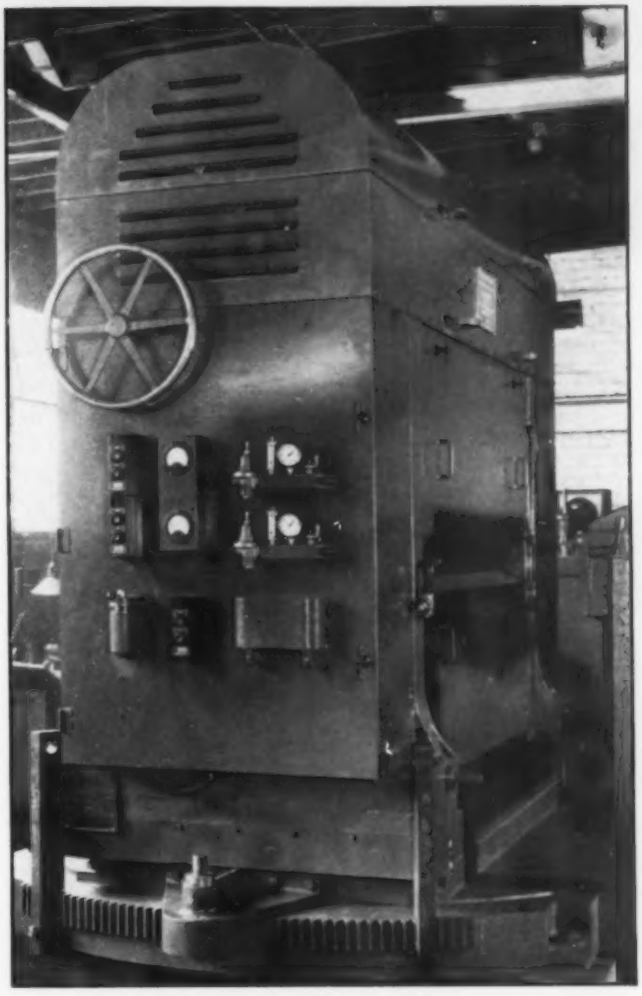


Figure 8 — The controls for the grinder are mounted on the side of the machine.

This equipment is operated to accomplish three processing functions on metal strip or sheet.

1. *Removal of defects* — an intermediate grinding operation for the removal of metal surface defects prior to additional cold reduction.

2. *Scouring* — also an intermediate grinding operation whereby very fine abrasive action imparts uniformity to surface condition prior to final rolling.

3. *Polishing or buffing* — a final finishing operation for high lustre or mirror finish after final rolling.

These functions are accomplished as a result of the following distinctive features of the machines.

Liquid grinding — First is the liquid grinding technique. Wet grinding boosts abrasive life since it keeps the abrasive "washed" clean and free for effective cutting and tends to keep cuttings scrubbed off of the metal before and after grinding. More important, it keeps the metal cool and prevents burning. A high pressure per unit (80-100 lb) and volume (150 gallons) is found most effective. For light skin passes, where a uniform polished surface is required prior to very light final reduction, a soluble oil solution is found desirable. Where a buffing or polishing operation is required (which necessitates the substitution of buffing belts instead of abrasive), then it is advisable to inject emulsified buffing compounds through the spray nozzles instead of either water or soluble oil. So far as surface quality of product is concerned, wet or lubricated grinding is of vital importance since it produces a very smooth polished or bright cut which rolls out into a higher lustre finish. In addition, wet grinding smothers the injurious grinding dust thus removing the resultant silicosis hazard. In current dry grinding operations, this hazard is partly overcome only by the installation of costly dust-collecting systems.

Diagonal grinding — Another technique offered by this equipment is diagonal grinding. This is accomplished by adjusting the machine obliquely on its swivel base up to an angle of approximately 20 degrees. The greater angularity of grit line produced in the diagonal grinding pattern, the quicker the grit line rolls out. This is of vital importance not only in grinding straight chrome stainless steel, but in all intermediate grinding of other steels because when these grit lines are cut into the surface in a straight line paralleling the edge of the strip or longitudinal direction of the strip, the grit lines are tremendously lengthened during the longitudinal reduction of the strip in the rolling process. This principle has been proven by actual tests on stainless steel showing that the clean diagonal grit lines roll out quickly even with very light reduction. Better observations were made, however, by painting on a segment of lead strip various lines 1 in. long to simulate grit lines in exaggerated form. After one rolling through

a small hand mill which reduced the strip 0.005 in., the difference in elongation of the lines was noticeable. The longitudinal line had lengthened out parallel to the edge of the strip from 1 to $1\frac{5}{8}$ in. Another line, being on a diagonal, had lengthened to $1\frac{5}{32}$ in. while a third line, being on a greater diagonal, had become elongated only $\frac{1}{16}$ in. A double diagonal type of grinding can be accomplished by setting two or more machines in tandem at reversed angles. This may enable an operator to break up or overcome an objectionable pattern in the surface of the strip.

Oscillation and reciprocation — Oscillation and reciprocation are also important features, especially in the buffing function. The oscillatory and lesser vibratory movement provides constant non-repetitive motion to the grinding surfaces. Such movement not only oscillates or "breaks up" grit line directions, but serves to sharpen and resharpen constantly all cutting edges of the abrasive grain. In addition, the abrasive has less chance of "loading up" due to the cleaning action of this movement. The slow reciprocation or reversing movement of the machine crosswise of the strip also aids in cleaning the abrasive. By this means, too, a full coverage of abrasive on the grinding roll can be utilized economically regardless of how narrow the strip material might be. In the conventional methods of abrading stainless and high alloy steels, objectionable longitudinal grit lines are often encountered. These longitudinal grit lines naturally lengthen in rolling. In later fabrication involving bending or deep forming, the steel then often breaks open along these imbedded grit lines. Such a condition is minimized in steel ground on this machine because the oscillatory and reciprocating movements, when combined with liquid grinding on the diagonal, tend to "break up" and overcome the severe grit line patterns. Combined reciprocation and oscillation furthermore enables a much finer finish to be obtained with the use of coarser abrasive.

Pneumatic drums — The two pneumatic rubber drums with abrasive coverings introduce the technique of grinding both sides of the work simultaneously. Like a tire inner tube, these pneumatic drums are resilient and provide a cushioning effect while in contact with the work surface. This resiliency primarily enables the abrasive to "get beneath the cut" and stay there, and thus definitely remove metal when desired. It also allows for uniformity of grinding in the case of slight contours or irregularities of gage. The cylindrical circumference of the abrasive combined with a resilience of action eases the behavior of the abrasive composition. No acute angles of cutting force are present, nor is there severe flexing of the abrasive belt which so often tends to rupture the bond and allow wasted unused abrasive grain to sever itself. Drum pressures are all controlled so that, within limits, a desired degree of cushioning can be obtained on either side of the work.

Production benefits — Finally, the operating accomplishments of these machines are readily apparent. Regardless of which function is performed (grinding, scouring or buffing), both sides of the work are processed at once resulting in increased production speed. Further shortening of the manufacturing cycle stems

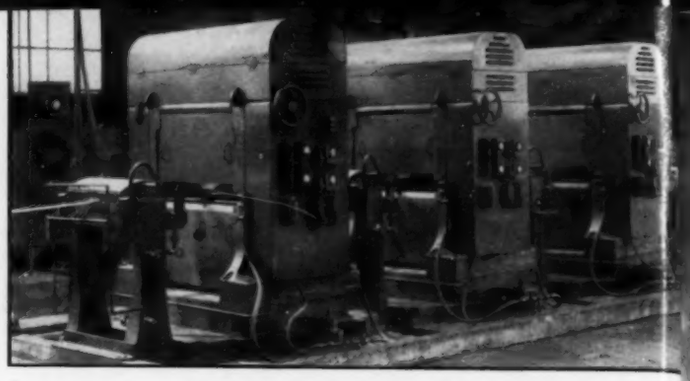


Figure 9 — The battery of tandem grinding machines enables this operation to be put on a real production basis.

from a tandem battery setup. (A battery of at least three machines is preferable especially in scouring or polishing where finer abrading action is necessary.) Figure 9 shows such a battery recently installed in a stainless mill. Here, completely between coiler and uncoiler, a staggered sequence of diagonal, oscillation, abrasive grain sizes and grinding pressures can all be employed to obtain continuous finishing operations. Since the steel is kept cool, successive uninterrupted passes can be made if necessary, and hot air nozzles can be applied to dry the strip before coiling with paper filler. Direct labor savings are apparent, too, since any one operator can control a battery of machines. Surface speeds of the drums can be predetermined and usually range between 4000/6000 fpm, depending on the operation required. This initial abrading speed far surpasses that of stationary drag-blocks so commonly used. With proper coiling facilities the travel speed of the strip can range anywhere up to 500 fpm. In the case of sheet processing, slower speeds are necessary since grip rolls instead of coilers are used to convey the work. Future development will, of course, make possible higher effective speeds. All non-operating servicing is reduced to a minimum and consists mostly of:

1. Abrasive belt changes. (These occur at varying intervals depending on the operation or grit size of abrasive. Since the abrasive coverings are wound on spirally without removing drums, such changes should be held to a 5-minute maximum element.)

2. Pneumatic drum changes. (For removal twice a year.) By simple crank action, the main housings are separated allowing removal of rolls through the top. Removal time should be kept to 20-minute maximum.

The machines described here have their chief application in steel strip and sheet grinding and polishing with particular emphasis on straight chrome and 18-8 stainless. However, experiments have proved that this equipment lends itself also to the conditioning of other materials such as precious metals, bi-metals, plastics, non-ferrous metals, etc. In short, these grinding and finishing machines open the way for new and superior finishing techniques in the steel and other industries.

DISCUSSION

PRESENTED BY

THOMAS S. McNEELY, General Grinding Foreman, Pittsburgh Crucible Steel Company, Midland, Pennsylvania

A. E. HAMILTON, JR., Vice President, Hamilton Pump Company, Inc., Pittsburgh, Pennsylvania

G. S. EISAMAN, Sales Engineer, Carborundum Company, Niagara Falls, New York

E. D. GIBSON, Superintendent, Steel Conditioning, Republic Steel Corporation, Canton, Ohio

FRANK A. SNYDER, Assistant Division Superintendent of Rolling Mills, Carnegie-Illinois Steel Corporation, South Works, Chicago, Illinois

ROY P. TOOKE, General Superintendent, American Rolling Mill Company, Butler, Pennsylvania

Thomas S. McNeely: There are several questions I would like to ask about the slab grinder. First, no mention was made of the variations in the length of intermittent conveyor table travel. Are such variations of any value, and, if so, how are they accomplished?

A. E. Hamilton, Jr.: At one time I did make reference either to intermittent or constant conveyor travel. At present it is the policy to use intermittent conveyor travel. I would like to answer that question in reverse by first pointing out how this is accomplished.

The intermittent travel of the conveyor is synchronized with the transverse cross grinding stroke of the head itself. This is accomplished in the pulpit table by means of cam discs, which can be varied both as to their length and as to their position on a cross bar which is motivated by the moving head when it traverses across the slabs. The cam discs in turn trip limit switches thus reversing the motors.

The purpose of this, I might say, is twofold. First, it allows us additional variety in our ability to manipulate the speeds of the machine. Second, it enables us to vary the movement of the intermittent conveyor travel, moving it either on one extreme end of the stroke or on both extreme ends of the stroke, or we can start the intermittent travel within a fraction of an inch of the edge of the slab. By that I mean that intermittent conveyor travel can start when the wheel reaches ½ in. from the far edge of the slab on the forward stroke, or ½ in. from the far edge of the slab on the return stroke; or when the wheel is 1 or ½ or 2 in. from the edge of the slab, or, if you please, in the middle of the slab. All of this gives us more variable maneuverability with respect to the travel of the machine and lets us then acquire the ultimate objective, which is maximum speed commensurate with the amount of metal to be removed.

Thomas S. McNeely: What is the maximum continuous speed of the conveyor table?

A. E. Hamilton, Jr.: When the conveyor table is traveling constantly, not intermittently, we can attain a speed of 3 fpm under the present conditions. However, on this machine there is a 10 hp motor which, incidentally, is reduced by a ratio of 3120 to one, a terrific reduction and probably more than necessary. With that reduction, it is easy to see that unusual speeds can be obtained and, as a matter of fact, on future machines we have designed and intend to employ a rapid traverse which will enable perhaps 100 or 150 fpm conveyor travel for specialized purposes, such as grinding in localized spots.

Thomas S. McNeely: You gave the maximum slab width as 24 in. Could the conveyor table be adjusted to grind the edges of such a slab?

A. E. Hamilton, Jr.: The conveyor could be adjusted or the machine could be adjusted. On future machines, by raising the head 24 in. slabs can be turned up on edge and can be ground individually or in numbers. The flat surfaces then could be ground by employing a dummy "build-up" on the conveyor.

Thomas S. McNeely: You did not mention the minimum length of the cross-grinding stroke. Would that permit grinding narrow slabs economically?

A. E. Hamilton, Jr.: There is a minimum length stroke right now on the 24 in. machine, because we felt that if any narrow slabs were to be ground (or narrow billets, such as 3 × 3 or 4 × 4), they could be ground in plurality by simply ganging one along side the other with 1 or 2 in. spacers in between them. It is possible, however, to make revisions to reduce that minimum stroke.

Thomas S. McNeely: When you are grinding slabs, it is often necessary to do a lot of heavy corner grinding. Could you accomplish this on the machine?

A. E. Hamilton, Jr.: It will not be accomplished on this first and original machine. However, we have designs for that on future models where, by the use of multiple edge grinding wheels, operated either by spring tension or pneumatically, we can grind the edge corners of the slabs either as we are grinding surface portions or the edges.

I know that some customers require ¼ in. radius, or a nicely beveled slab. It might be in the picture to acquire that with this grinder, or it might be necessary in the final analysis to put a little handwork in to make such a clean radius.

Thomas S. McNeely: A large percentage of the down-time was due to crane delays in handling the steel. Could something be done to make handling an integral part of the machine?

A. E. Hamilton, Jr.: We have visualized jib cranes. By employing two jib cranes, if necessary, one on either side of the head of the machine, the table could be loaded and unloaded from the extreme positions either on the left or right of the machine. I think this would go a long way towards reducing the tremendous down-time due, not always to a lack of cranes, but to the lack of crane service.

Thomas S. McNeely: You gave your grinding wheel size on the present machine as 30 × 4 × 12. Would a wheel of greater thickness provide any savings?

A. E. Hamilton, Jr.: We feel that possibly a wheel of greater thickness will provide considerable savings. The machine, incidentally, is designed to take up to a 36 in. diameter, 6 in. face wheel. There will be some refinements necessary yet before we could make a determined statement on whether or not larger wheels will prove valuable.

Right at this point we are working out the details of the mechanism to reduce the extremity of the oscillatory and lesser vibratory movement of the wheel. When that is done so that the wheel will simply skip over the surfaces of the slab with just enough oscillation to maintain a wheel-cleaning action, then, by all means, a 6 in. face wheel will enable us to acquire faster speeds compared to a 4 in. face wheel.

Thomas S. McNeely: How long does it take to change one of those grinding wheels?

A. E. Hamilton, Jr.: I have seen it take 15 minutes, and I have seen it take three-fourths of an hour. Again, the crane service comes into play. We feel that with the proper attachments, it should take no longer than 5 or 10 minutes which, I believe, is the approximate time it takes to change a swing frame grinder's wheel.

Thomas S. McNeely: We ran into a little trouble with the loading of the grinding wheel. What have the various grinding wheel companies done towards testing wheels at such pressures?

A. E. Hamilton, Jr.: The grinding wheel companies will have to speak for themselves on that, although, first, I would like to say that should a wheel begin to load — and it is usually evident immediately in the surface conditioning of the slab — it can be quickly and readily unloaded in one of two fashions: by either making sure that the extremely fast oscillation movement is operating, which will tend to make the wheel self-cleaning, or by reducing and, if necessary, eliminating altogether the water applied to the wheel. I have seen a fully loaded wheel unloaded dry in a matter of five or ten seconds when we were experimenting with various grades of wheels.

As for your exact question as to what the grinding wheel engineers are developing on this application, some of the grinding wheel men here may like to comment on that point.

G. S. Eisaman: We have encountered very little trouble with wheel loading. When this condition existed we shut off the coolant, namely, water, and the wheel was operated dry for several passes. This removed the metal load from the wheel face.

We did not conduct any tests to determine the pressure that our wheels would withstand. Our regular line of wheels used on swing frame grinders has been entirely satisfactory on this machine.

E. D. Gibson: I have one question. You quote 0.74 hours per ton. Is that the complete slab, defect free, or is it just the flat surface?

A. E. Hamilton, Jr.: Just the flat surface, and it does not include edge grinding.

E. D. Gibson: That would be another process adding additional expense?

A. E. Hamilton, Jr.: Edge grinding at present would definitely be another auxiliary process. However, one of the future developments, I think it was brought out by another question here, will be our contemplated edge grinding simultaneously with the grinding of surfaces, or following the grinding of surfaces through an additional or secondary machine.

E. D. Gibson: In the surface removal in the spray, how is the abrasive and metal loss disposed of in the wash?

A. E. Hamilton, Jr.: The spray, and particularly the violent spray which is directed into the grinding wheel as it traverses the slab, washes the greater bulk of all the metal and what little abrasive there is into the water trough at the far end of the machine. There is a guard at the extreme end of the stroke beyond the middle of the head which tends to catch all those cuttings. From there they fall into a tote box, which periodically, at least every eight hours, is emptied and removed. No official testing of the metal grindings has been made, but we feel that there is a considerably high percentage of metal and a very minute percentage of abrasive in what residue we obtained.

Thomas S. McNeely: I would thoroughly agree with the idea that was just expressed. I think there is a much higher percentage of metal than abrasive. I believe we get around about 50-50 abrasive and metal, but I believe your analysis showed about 90 per cent metal and 10 per cent abrasive. Is that right?

A. E. Hamilton, Jr.: As I said we have made no formal analysis, but we have looked very scrutinizingly at the cuttings under a glass, and there is practically no abrasive that we can see in the residue.

Frank A. Snyder: There are a few questions that have not been answered to my satisfaction. The grinding of the corners of the billets or the corners of the blooms that may need salvaging has been very skimpily passed over. That is much more of a problem than has been mentioned. I appreciate this paper very much in general, because it has attempted to do some of the things in straight-line production that we have been after. However, there are several questions.

With a 4 or a 6 in. wide wheel, how do you remove deep defects in the slab? You mentioned that this machine ground two sides at once. Is that statement right, or is it wrong?

A. E. Hamilton, Jr.: I think you are confusing the slab grinder with the finishing machine. The slab machine grinds one side, although the illustration showed a two-gang setup involving two slabs, there being one surface or one side each of two slabs.

Frank A. Snyder: How do you remove the deep defects?

A. E. Hamilton, Jr.: Let me counter that with another question. By deep defects, do you mean deep defects throughout the entire surface of the slab?

Frank A. Snyder: Localized deep defects. They may be a foot long; they may be two feet long; they may be small cracks, or they may be embedded scabs or other defects.

A. E. Hamilton, Jr.: If you can visualize once more the picture of the slab grinder, the head, as I have attempted to explain, traverses the slab or slabs as they are moved intermittently under the head. Now, the head can be immobilized in its cross grind movement so that it can stop, we will say, in the center of a slab where there happens to be a localized scab or pit, or let us say, a four-foot length of seam, and having the cross grind demobilized, the conveyor table with the work can then be moved directly under the wheel, and with or without oscillation of the wheel at three feet a minute (and at the operator's discretion with respect to pressure) he can remove that surface seam.

Frank A. Snyder: Do you tilt the wheel when you do that?

A. E. Hamilton, Jr.: If it is, for instance, a very, very little seam, or appearing thus to the operator, he may wish to demobilize the wheel on that spot and, at the same time, demobilize the oscillatory movement of the wheel to prevent any deep grinding or snagging, and simply whisk out a minor amount of metal to get that seam out. If, on the other hand, it appears to be a heavy defect, he may want to really dig out metal there, and, of course, the more oscillation there is which allows the edge of the grinding wheel to snag deep down into the steel, the more metal will be removed either in localized grinding or total surface grinding.

Frank A. Snyder: I believe you made another statement about the multiple grinding of 3⅞ in. billets. What did you mean by that?

A. E. Hamilton, Jr.: I think I said 3 × 3 in. However, at present our experience has been totally with the slab sizes ranging from 6¼ to 16 in. wide and from 26 to 30 ft long, although the machine will accommodate 24 in. widths. Still there is no reason why, we will say, four small billets with proper handling attachments (such as block spacers between them) cannot be ganged in plurality along the table. It makes no difference whether they are level or not, because the grinding wheel, through the pneumatic behavior of the swing arm operating vertically on trunnions, can still grind the slabs despite the irregularity.

Frank A. Snyder: It is very important to grind the corners. The surfaces are more or less insignificant compared to the corners, as a general rule, on small billets.

A. E. Hamilton, Jr.: May I make the admission that we have a long way to go yet in the final development of this machine. At the same time, however, it is our sincere feeling that we are on the right track.

Roy P. Tooke: I have one question on the strip grinder. Did I understand you to say that the pneumatic rolls on the strip grinder oscillate parallel to the axis of the rolls?

A. E. Hamilton, Jr.: Not the rolls themselves, but the entire machine on a secondary base oscillates not with a complete back-and-forth movement, but a movement all broken up (oscillatory with lesser vibratory movements) transversely of the travel of the strip and parallel to the axis of the rolls.

Roy P. Tooke: Across the strip? Is there any problem on a single-head machine when set at an angular position in guiding the strip, or is it necessary to have two heads? If you grind with one at 20 degrees to the travel of the strip, do you have any trouble with guiding the strip?

A. E. Hamilton, Jr.: We have no experience on a single-head machine. One is on paper but has never been built.

Roy P. Tooke: With two heads opposed does it cancel out so that the strip guiding is not a problem?

A. E. Hamilton, Jr.: I do not feel qualified to answer that. May I call on the man whose ideas are responsible for both of these machines, Mr. Hamilton, Sr.? I am sure he can give you an answer on that particular question.

A. E. Hamilton, Sr.: I think the gentleman has reference to two machines instead of two heads, setting one machine at one angle and the other machine at another.

Roy P. Tooke: That is right.

A. E. Hamilton, Sr.: The angularity of a second machine would more or less offset the angularity of a first machine, thus counter-balancing any tendency for lateral thrust of the strip. On a very thin strip the machine should not be cocked around at such an extreme angle because of the danger of injuring the edges of the strip.

The Annual Spring Conference

OF THE

ASSOCIATION OF IRON AND STEEL ENGINEERS

WILL BE HELD

APRIL 26 and 27, 1948

IN THE

HOTEL STATLER

BUFFALO, NEW YORK

Modern Design of Multiple Fuel Steam Units

. . . . increased knowledge and more advanced techniques of boiler design have resulted in an increased availability of such units to the operator . . . .

By A. R. MUMFORD
Development Engineer
Combustion Engineering Company, Inc.
New York, New York

▲AS the development of the art of boiler design progresses those elements of the design which restrict output by limiting the rate of steam generation or by compelling outages for maintenance are gradually altered to reduce or eliminate the particular restriction. When a number one cause of outage is eliminated the former second most important cause becomes the most important and becomes the object of concentrated study. It is not inferred that only one cause at a time is the subject of concentrated study but the most important naturally receives the most attention. An improvement in design must await the establishment of a performance record under commercial operating conditions before becoming widely accepted, and before that it must appeal to a purchaser sufficiently to warrant his trial of it. For these reasons improvements are not accomplished within short periods of time. During the passage of these time periods new problems are introduced frequently by changes in operating practices, and the economic availability of other fuels as well as changes in the nature of the load curve. The designer of a steam generating unit meets the problems and changes in practice not only with a background of experience with other units in the same industry, but with the broader experience based on all other industries. Design is evolving continuously therefore, not only to meet changing economic conditions but to increase the availability and earning power of the equipment. Availability is commonly defined as the ratio between the number of hours a piece of equipment is producing or is capable of producing and the total number of hours in the period, usually a year. In the utility industry, for instance, steam generators are commonly available well over 90 per cent of the time and in some instances have approached closely to 100 per cent in a given calendar year.

FACTORS INFLUENCING AVAILABILITY

Some of the more important factors which influence availability will be discussed in this paper. Many have been reduced in importance or eliminated by design changes, some are so closely connected with operating procedures that changes in design alone will probably never be completely successful in eliminating them.

Slag — Slag resulting from the unburnable mineral matter associated with coal has, in older designs, interfered seriously with the continuous production of steam at rated capacity. This material, heated to its softening or melting temperature in the flame, adheres to and builds upon the heating surfaces with which it comes in contact, gradually closing the free area available for the passage of the gas, increasing the resistance, and finally forcing operation at reduced capacity until the obstructions are removed. When this material deposits on the water cooled walls of the furnace, it insulates them and lowers the furnace heat absorption. Such a decrease in furnace wall absorption lessens the cooling action on the gas and causes it to enter the boiler section at a higher temperature, possibly high enough to maintain the slag in a sticky condition or to increase the difficulties of superheat control. Slag is of such importance to availability that factors affecting its control will be discussed more fully later in the paper.

Exposure of uncooled equipment — The introduction of fuel and air into a furnace cavity requires openings in the water cooled walls. Radiant heat from the flame will impinge on any equipment exposed by these holes and cause growth or warping which eventually necessitates an outage for maintenance. The exposed equipment is normally cooled by the flow of unignited fuel and air through it, or protected by a layer of such fuel and its ash as a supplement to the cooling air. If, however, the load requirements are such that part of the equipment is not needed part of the time, then the cooling effect is absent and damage results. The designer endeavors to shield the equipment from such radiant heat during its out of service period by interposing as much refractory or water cooled shielding as possible between the equipment and the flame without

Presented before AISE Annual Convention, Pittsburgh, Pennsylvania, September 23, 1947

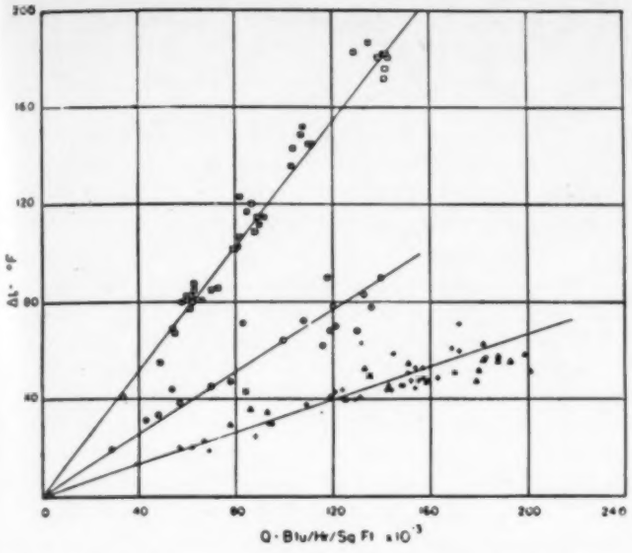


Figure 1 — Difference between tube surface and saturation temperature (△t), versus rate of heat transmission. Heat transmission increases linearly with temperature difference.

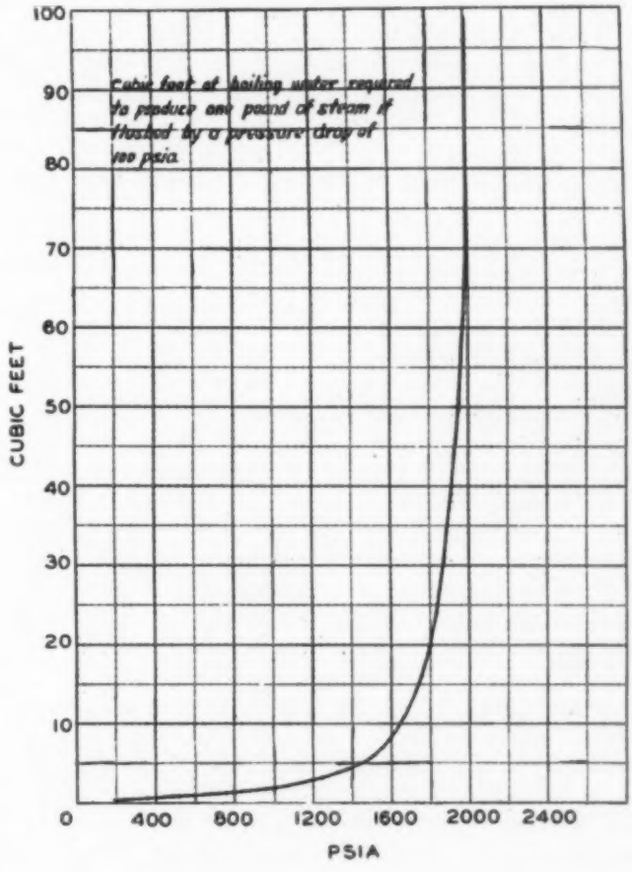
interfering with the operation or the equipment. In earlier designs flame temperatures were not as high as is common today and damage not so potentially immediate or extensive. Furthermore there was less likelihood of equipment being out of service because multi-fuel installations were not common. Today a steam generating unit in the steel industry is seldom designed for the use of only one fuel. Usually provision is made for separate or simultaneous burning of from two to four fuels. When the primary fuel is in plentiful supply, the secondary fuel or fuels are cut off and at this time the hazard of damage to uncooled or unshielded equipment exists. Burners have been cracked or warped and stokers have been given permanent waves of an amplitude great enough to make the stoker inoperative. The designer has become increasingly aware of this hazard to availability and has designed the installations with a maximum of refractory or water cooled shielding to protect it when load or fuel supply necessitate its being out of service, yet exposed to radiation from the flame of the other fuel. These shieldings are shown in the drawings presented later in this paper.

Water conditioning — Not much more than twenty years ago water treatment consisted of the addition of so many buckets of soda ash to the water supplied to the boilers. Pressures were low and boiler turbining a routine operation. As pressures rose so did saturation temperatures and so did rates of heat transfer through tube walls. Experience quickly proved that "so many buckets of soda ash" were no longer adequate to protect the pressure parts, and water conditioning suddenly matured as a necessary technical adjunct to steam plant operation. In the steel industry the chemical knowledge and ability is present in one phase of the operations so that the inclusion of the phase of steam production is an extension rather than a new division.

In a report on "Studies of Heat Transmission through Boiler Tubing at Pressures from 500 to 3300 Pounds" by W. F. Davidson and others,[1]* data was presented which showed that the difference in temperature between the outside surface of a tube receiving heat and the saturation temperature of the boiling water within the tube was proportional to the rate of heat transfer. The data showed further that, at the same rate of heat transfer, the difference in temperature was proportional to the wall thickness of the tube. This data is shown in Figure 1 which is taken from that report. Although there is some scatter in the points, it is obvious that a straight line is representative of the data. The significant facts apparent from this chart are as follows:

1. △t is directly proportional to the rate of heat transfer for each line. Thus △t doubles when Q doubles.
2. The bottom line represents the data for a tube with a ⅛ inch wall; the middle line a tube with a ¼ inch wall; and the upper line a tube with a ½ inch wall. With this in mind it is at once apparent that △t is directly proportional to the wall thickness of the tube at constant heat rate.
3. The lines have all been drawn so as to pass through the origin at zero. Although this is theoretically incorrect because of the existence of a slight temperature drop through the internal water film, it is evident that the resistance of such a film must be negligible compared to the resistance of the metal wall of the tube. If the drop through the film constituted a substantial part of the total drop, then it would be difficult to draw lines through the data. This serves to emphasize the importance of the wall thickness.

Figure 2 — Volume of water required to produce one pound of steam by flashing through a pressure drop of 100 psi versus initial pressure.



* Refer to Bibliography at end of article.

4. Each point for each line represents a different test with an indicated range of Q from 0 to 200,000 Btu per hr per sq ft or a wider range than has been reported in any commercial steam generators.
5. The internal pressure varied for the lower and upper curves between 500 and 3300 pounds and for the middle curve from 1500 to 3200 pounds. We can conclude, therefore, that $\triangle t$ is independent of the internal pressure and that the tube surface temperature can be expected to be the sum of the saturation temperature and $\triangle t$ at any rate of heat transfer. This is particularly important in designs calling for heavy walled tubes exposed to high rates of heat transfer and at high internal pressure. As the wall thickness is normally proportional to the diameter so the larger the tube the thicker the wall. Thus, a 4 inch tube for operation at 2600 psi absolute would have a ½ inch wall. The saturation temperature would be 674 F and at 160,000 Btu per hr per sq ft, $\triangle t$ would be 208 F. The surface temperature of the tube would be 882 F or approaching the temperature limit of the outside ligaments for boiler steel, and would be introducing a hazard. If the tube diameter were reduced to 2 inches, the surface temperature would drop to 778 F and a 1 inch tube could be expected to have a surface temperature of 726 F all at the same heat transfer rates and internal pressure.
6. Another feature of these curves is that the mixture of steam and water within the tube varied in quality over wide limits for each line. Actually the final quality at the discharge from these tubes was varied from 7 per cent to 100 per cent steam by weight, and no effect on $\triangle t$ was observed except in the superheat region. Thus, with sufficient mass flow of a mixture of water and steam through a tube, the proportions of steam and water do not affect the surface temperature of the tube.

The tests represented by Figure 1 were all made with good but not perfect water, and completed before noticeable deposits were formed on the internal surfaces. Obviously if scale had been present $\triangle t$ would have been increased by the temperature drop through the scale. Because of the high resistance of even a thin layer of scale to the passage of heat, the surface and average wall temperatures of even thin walled tubes may become dangerously elevated. It is obvious that water conditioning is of the utmost importance to availability. The designer can offer little help in this matter but must leave it in the hands of the operator to utilize the best available chemical knowledge to obtain and maintain scale or deposit free conditions on the internal surfaces of the steam generating unit.

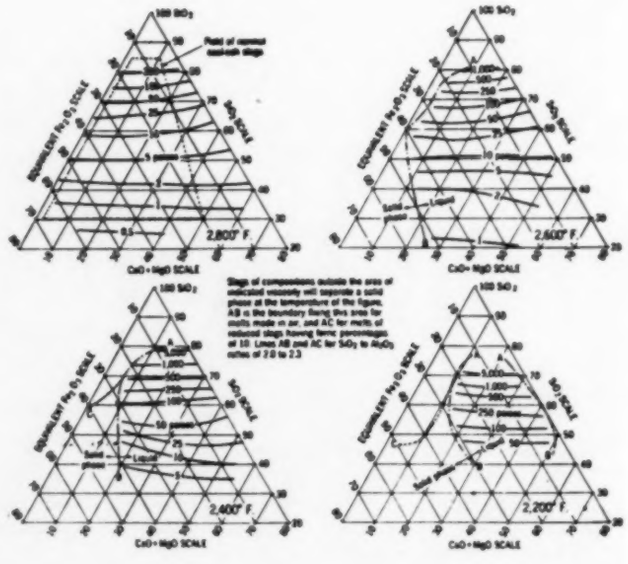
Scale not only introduces a resistance to the flow of heat thus raising the temperature of the tube wall, but also provides a stagnant pocket next to the inner surface of the tube in which chemicals can concentrate and attack the hot metal. The products of the attack are usually held in situ by the scale and the condition is aggravated.

The designer has the problem of preventing the discharge of moisture with the steam from the drum. Such moisture carries with it part of the chemical in the boiler water and on drying out in the superheater the chemical probably continues as a dry powder to the turbine where some of it deposits. Although the amount in the steam may be only 0.5 ppm, the cumulation from millions of pounds of steam affects the turbine performance. This problem has become increasingly difficult with increasing operating pressures and capacities, and although the separating efficiencies are now in excess of 99.9 per cent the operators request better efficiencies to improve the availability of the steam tubine-boiler combination. The principal difficulty is the discovery of a common denominator which will permit the correlation of the data from different conditions so that the fundamental factors will become more clearly evident.

To summarize, although water conditioning is an operating responsibility, its effect on availability is so large that the designer cannot avoid interest. If the water conditioning is inadequate, burnouts or internal corrosion will cause shutdowns and reduce availability. If the water conditioning permits the formation of scale, the designers' computations of the heat absorption intensities will no longer be valid and the balance between the work to be done in different parts of the unit will be upset. The influence of water conditioning on the steam purity is only partly understood and the designer although quite successful now is striving for further improvement.

Load variations — Availability under fairly constant demand for steam can be built into a unit more readily than it can under conditions of a widely fluctuating demand. Temperatures, stresses, and wear on moving parts are fairly accurately predictable under constant demand conditions. Where the demand fluctuates widely the temperatures vary, the stresses change, and the sudden application of load changes to moving parts changes their normal rate of wear. Historically the steel industry has utilized the flywheel effect of large volumes of boiling water in the pressure vessel, which when the demand suddenly increased would convert some of its stored heat into steam as the pressure fell

Figure 3 — Effect of slag composition on viscosity. Tests indicate that the viscosity of slags is approximately independent of the Al_2O_3 content for SiO_2—Al_2O_3 ratios of 1.5-3.0; alkalies are not more than 2.5 per cent of the original slag.



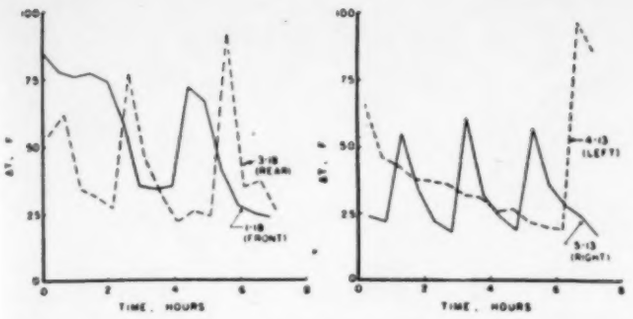


Figure 4 — Behavior of thermocouples at mid-point of each wall of pulverized-coal fired furnace.

and thus afford the operators time to increase the heat input. At low pressures this flywheel effect is undoubtedly helpful, but as the design pressures rise the available heat decreases and above 1500 psi absolute the volume of boiler water required to produce 1 pound of steam rises very rapidly. On the assumption that a drop in pressure of 100 psi is permissible on the application of a sudden demand the following table shows the volume of water required to produce one pound of steam.

The curve showing the volume of water required to produce 1 pound of steaming by flashing to a pressure 100 psi lower than the indicated operating pressure is presented as Figure 2. The rapid rise of the required volume with increase of pressure is clearly evident.

Obviously if operating pressures increase to 2000 psi, absolute over 200 times as much water would have to be present in the unit to have the same flywheel effect as an equal pressure drop at an operating pressure of 250 psi absolute. A unit containing enough water to do this job would be slow to come on the line, not only because of the mass to be heated but because temperature stresses in drums would develop with too rapid heating.

The steam generator designer, with the co-operation of control manufacturers and designers, is more hopeful that by maintaining the heated mass at a reasonable value and arranging to increase the rapidity of response to demand, he will be able to increase the heat input rapidly enough to offset the lost flywheel effect of flashing as operating pressures rise. Any success in keeping the quantity of the heated mass to a low value will reduce the stresses caused by rapid changes of temperature and have a favorable effect on availability. The situation with respect to moving parts involves less heavy equipment and although wear will always be greater with fluctuating demand, its effect on availability will probably be minimized.

TABLE I

Operating pressure, psia	Dropped to psia	Lb steam flashed per cu ft liquid	Cu ft liquid required for 1 lb steam
2000	1900	0.0104	96.5
1800	1700	0.05	20.0
1500	1400	0.174	5.75
1250	1150	0.322	3.11
1000	900	0.523	1.91
800	700	0.635	1.57
500	400	1.10	0.91
350	250	1.515	0.66
250	150	2.18	0.46

In units utilizing two or more fuels, controls are now in operation which change the heat input rapidly not only as required to meet fluctuating demands, but also to meet fluctuating supply of the primary fuel. It is not, therefore, too optimistic to say that rising operating pressures will change the manner of meeting fluctuating loads without introducing obstacles of major importance. One of the units to be described later is designed for 900 psi gage at the superheater outlet, and 900 F total temperature so high pressure steam generators are becoming more common in the steel industry.

STEAM TEMPERATURE

As design pressures rise design temperatures rise in order that the economies of power generation may be realized. At the higher temperatures, the proportion of the heat input utilized for superheat increases and the importance of the superheater is enhanced. Although steel mills may not look forward to part load operation in the near future, the usual design requirement is that the superheat reach the desired temperature at some part load and remain essentially constant up to maximum load. The maintenance of the desired superheat temperature at any load requires that the heat absorbing surfaces of the furnace and the boiler screen be maintained free of insulating deposits in order that the heat delivered to the superheater be not excessive. If the design does not take care of furnace absorption adequately, the availability of the unit will be affected. This feature will be discussed more fully in the detailed discussion of slag deposits.

In designs utilizing two or more fuels, the designer must not only maintain the superheat temperature over a range of loads with the primary fuel but must also arrange the equipment so that temperature fluctuations are minimized when the secondary or other fuels are used. For steel plants the primary fuel is always blast furnace gas and the products of combustion are most voluminous for this fuel. The large volume of the products of combustion is accompanied by high rates of mass flow, and therefore, causes the convective heat transfer rates to be higher than for the supplementary fuels. By arranging the firing position of some of the supplementary fuels so that the radiation component of heat transfer to the superheater is higher and so that the amount of furnace cooling surface passed over by the combustion products is somewhat less, the effect of the reduced convective component is offset. Coke breeze, however, is fired on stokers at the bottom of the furnace and cannot be positioned to compensate for the decreased volume of combustion products, so some variation in steam temperature may be expected with this fuel used as a secondary fuel. If the temperature variations are not too great, the economy of power generation alone is affected but, particularly at high steam temperatures, wide variations may affect the turbine because of temperature stresses. The designer's ability to locate the point of supplementary fuel firing and actually to change the direction of firing by utilizing tilting burners, as with pulverized coal, has minimized the steam temperature changes to be expected from fuels of such different characteristics.

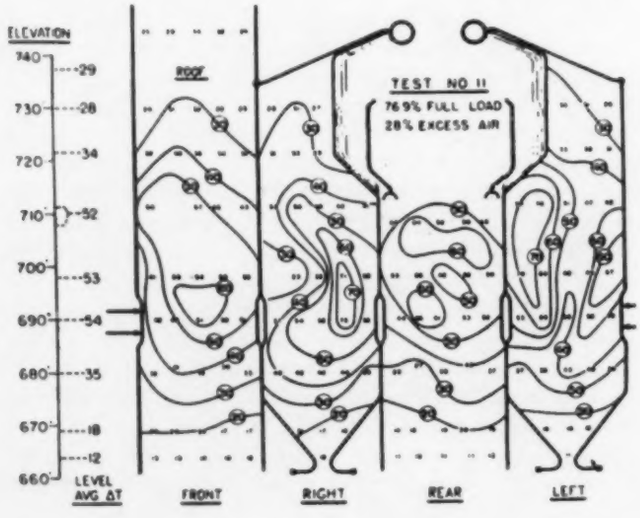
DETAILED EXAMINATION OF FACTORS AFFECTING SLAG

The U. S. Bureau of Mines has conducted extensive research work on the properties and behavior of coal-ash slags. Messrs. Nichols and Reid reported on the "Viscosity of Coal-Ash Slags" in 1940.[2] Although this work was directed primarily toward the determination of factors affecting the removal of ash in the liquid form from pulverized coal furnaces, it is of great interest to the operators of steam-generating units in the steel industry who burn coal or coke as a supplementary fuel to blast furnace gas.

In Figure 3 is reproduced Figure 8 of their paper in which, on triangular coordinates, the effect of composition on viscosity and flow limits is shown. The number of variables in the composition of the slag has been reduced by limiting the ratio of SiO_2 to Al_2O_3 to a constant value of about 2 for these charts and by combining two of the fluxing components, CaO and MgO to provide a single scale. Each triangle represents a condition at one temperature, namely 2800, 2600, 2400 and 2200. This series of figures represents only one slag, but experimental evidence indicates that some generalized conclusions can be drawn from them. Because the dust in blast furnace gas contains about 50 per cent iron with some lime (CaO) flux, the effect on coal or coke ash of the mixing of this dust with the ash dust in the flame can be predicted.

In these charts the composition of an ash is shown by a point satisfying the quantities shown by the analysis. The addition of Fe moves the point downward parallel to the left leg of the triangle. Blast furnace gas dust contains about 50 per cent Fe and its addition to the ash from any coal would lower the viscosity of the molten product at 2800 F. At the lower temperatures shown by the other triangles, the dotted lines A-B and A-C represent the dividing line between the solid and liquid phases of the slag under oxidizing and reducing conditions respectively. Assuming a reducing atmosphere in the flame, it is evident that the addition of iron would tend to liquefy an ash which would normally

Figure 5 — Isothermal △t diagram in pulverized-coal fired furnace.



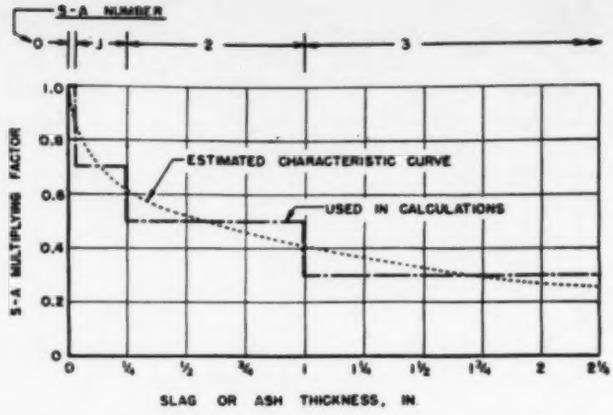


Figure 6 — Slag-ash factor for various slag thicknesses.

solidify at the lower temperatures. Under oxidizing conditions the viscosity of the liquid mixture would be reduced by the addition of iron, but a sufficiently large addition might cause solidification. Oxidizing conditions will exist outside of the flame proper so that the change in physical properties even at constant temperature as the droplet of molten ash moves from one region of the furnace to another is complex. Little is known of the effect of the addition of Fe at temperatures at which the normal ash may be solid. We may assume that it will broaden the range of temperatures in which the mixture is sticky or pasty and likely to adhere strongly to comparatively cold surfaces.

Addition of lime, which is also contained in blast furnace gas, serves to move the composition point to the right parallel to the base of the triangles. According to the amounts of dust and its composition therefore, the slag from coal or coke may be kept from solidifying as the gas temperature drops near the wall.

The steel industry has recognized the adverse effect of blast furnace gas dusts on solid fuel ashes by removing that dust so that as little as 0.01 grains per cubic foot remains. However, even this small amount has been blamed for increased adherence of slag in furnaces in which solid fuel is burned simultaneously with blast furnace gas. It is evident that a fluxing action takes place and the designer must so design the furnace that the fluxing action of the dust, and the resulting insulation of the cooling surfaces is minimized in furnaces designed for the simultaneous burning of solid fuels and blast furnace gas. The problem can be expected to be somewhat more difficult as blast furnace gas becomes dirtier, and the boiler furnaces must become more moderate in absorption rates to compensate. A balance will eventually be indicated which utilizes a furnace and a dust cleaning procedure which combined have the highest economic efficiency.

In the absence of information as to the detailed changes in temperature and composition affecting the slag particle, we can assume a series of changes to fit the overall conditions. The ash particle in the flame, if solid initially, will be liquefied by the addition of Fe and CaO from the blast furnace gas dust. As it approaches the cooling surface of the walls or boiler convection surface, it will be cooled perhaps enough to solidify it according to its composition. If sufficient time is pro-

vided during which the droplet is passing through the oxidizing zone outside of the flame envelope and before contact with the cooling surface, it may lose some or all of its sticky property and become a solid which will not adhere strongly to the cooling surface. The indication is that high intensity of heat absorption should be sacrificed to allow time for cooling the particles. Under such conditions furnace walls may become "self-cleaning" as was indicated in a report of the Special Research Committee on Furnace Performance Factors. In the first part of that report entitled "Variations in Heat Absorption as shown by Measurement of the Surface Temperature of the Exposed Side of Furnace Tubes" by Lyle B. Schueler,[3] Figure 4, which is also Figure 4 of that report, shows the variations of the mid-point thermocouple with time for each wall. The sharp rises in temperature are explained as the dropping off of ash deposits which apparently had increased in thickness and weight enough to exceed the strength of the bond with the tube surface. In the case of each wall except the left, the self cleaning feature is evidenced by the regularity with which the ash coating drops off. Roughly the rate of heat absorption in this particular case was 1000 Btu per sq ft for each degree F of $\triangle t$. The insulating effect of an ash deposit can be determined from these charts to be enough to reduce the heat transmitted 35,000 out of 60,000 Btu per sq ft per hr for the right wall up to 80,000 out of 100,000 Btu per sq ft per hr for the left wall. Figure 5, which is Figure 7 of the original report, shows the average isotherms for

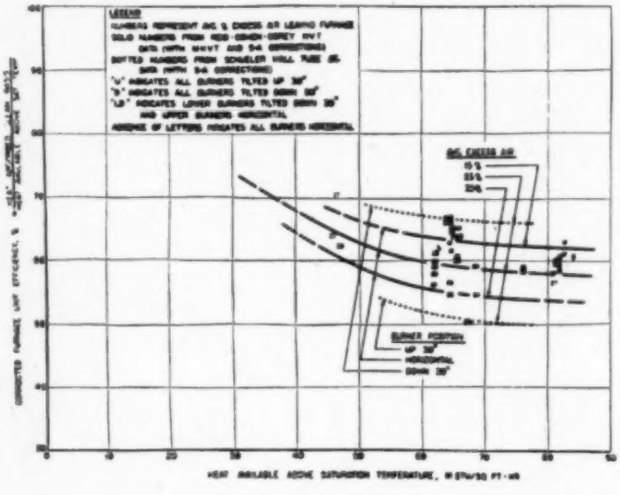


Figure 7 — Furnace unit efficiencies based upon heat available above saturation temperature and corrected to clean furnace conditions.

each wall for the same test. In Part 4 of the same report entitled "Comparison and Correlation of the Results of Furnace Heat Absorption Investigations,"[4] the effect of ash deposits on heat absorption is indicated. Figure 6, numbered Figure 5 of that report, shows the relation between a multiplying factor and the thickness of the ash deposit. Thus, for a deposit 1 inch thick, the heat transmitted would be only 0.4 of that for a clean surface. In Figure 7, Figure 10 of that report, is shown the effect of excess air, rating, and firing direction on furnace efficiency. As would be expected, lowering the excess air increases the furnace efficiency at all ratings while increasing the excess air has the opposite effect. A new factor, the adjustable burner, has been introduced to aid in the control of superheat and has been applied to many boilers in the high pressure high temperature field where superheat control is of great importance. This burner is adjustable so that the flame may be directed up from the horizontal about 30 degrees, and down from the horizontal about the same amount. The effect of this adjustment is shown by the dotted lines. It is quite evident that the furnace efficiency can be increased or decreased at will over a wide range by changing the firing direction. The effect on the temperature of the gases leaving the furnace was over 400 F so that superheat control was placed more completely in the hands of the operator over wide limits. In the

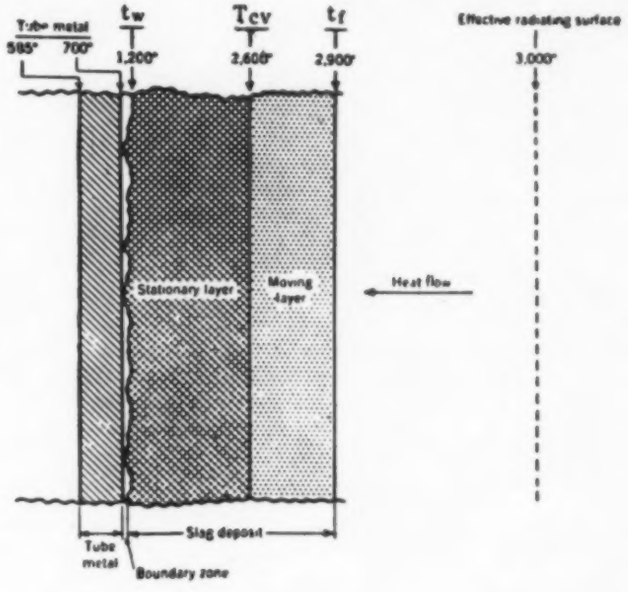


Figure 8 — Temperature distribution in slag deposit. The temperature on the outside of the tube may be high.

case of this boiler, presented as an example of what the designer is doing to lessen the effect of accidental insulation of furnaces by ash deposits, a conservative design is shown to be at least partly self cleaning with added control given the operator to offset any changes introduced by changes in fuels.

A continuation of the U. S. Bureau of Mines study was reported by W. T. Reid and P. Cohen in 1944 entitled "Factors Affecting the Thickness of Coal-Ash Slag on Furnace Wall Tubes."[5] In Figure 8, Figure 1 of that report, the authors show their conception of the nature of ash deposits on furnace tubes. The rather high figure for the temperature of the outer surface of the tube may be questioned. Under similar conditions this author has measured temperatures of 590 to 625 F. A temperature of 700 to 750 F may exist before the ash starts to accumulate but would drop rapidly as the ash insulates the surface. Undoubtedly a sharp rise in temperature of the surface of the ash occurs even when the surface is first dusted. As the layer of ash increases in

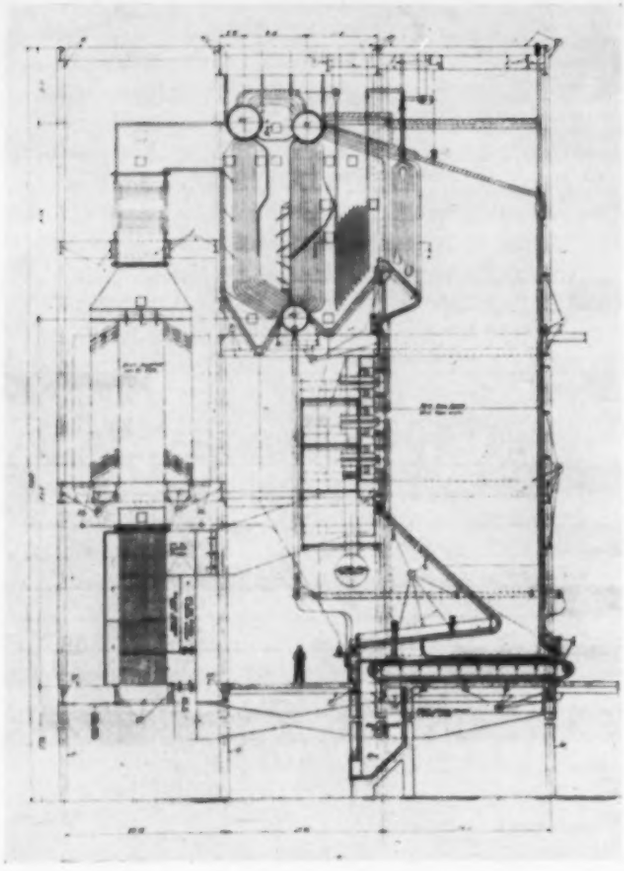


Figure 9 — Unit of 325,000 lb capacity for Bethlehem Steel Company at Sparrows Point, Maryland. Pressure is 900 psi at 900 F.

thickness, its surface temperature will rise until the temperature of the critical viscosity is reached above which the ash becomes more and more fluid as the temperature rises, until it flows as a liquid to the furnace bottom and is removed as a liquid. Obviously the temperature of the outer surface of the tube is directly affected by the rate of heat transfer and when the designer keeps that rate down to a moderate figure the surface temperature will be lower. The sticky nature of a droplet of molten ash is retained only as long as it is prevented from cooling by being surrounded with hot gases or because the period between its escape from the flame and its impingement on water-cooled surfaces is too short. This time element is probably a factor of the ratio of the area of the flame and the area of the furnace cooling surface. The designer has been successful in decreasing ash deposition on parts of the furnace envelope by replacing the large low velocity burners with burners designed for higher velocity and for direct and positive mixing of the fuel gas and air. The effect has been to bush out the flame, raise the local intensity of combustion, shorten the flame and allow more time for any molten particles to solidify before impinging on the heat absorbing surfaces.

The designer's problem, when two or more fuels are used, is to maintain the right mixing and intensity of combustion with each alone or in combination, so that combustion is completed and the flame temperature begins to fall a sufficient distance from cold surfaces so that adherence of slag is minimized. As has been indicated this problem is attacked by utilizing a combination of available factors. Generally a conservative furnace design is a basic requirement. This maintains moderate rates of heat absorption and resulting low tube surface temperatures. By burner design, flame length is controlled to permit chilling of slag droplets. By burner position, differences in fuel characteristics are compensated for to maintain superheat. By arranging the cooling surface so that the gas passages past the first cooling surface are large, cooling is accomplished before the narrow passages, which might be bridged and clogged, are reached.

As the art develops, the designer is continuously applying the findings of research and field performance

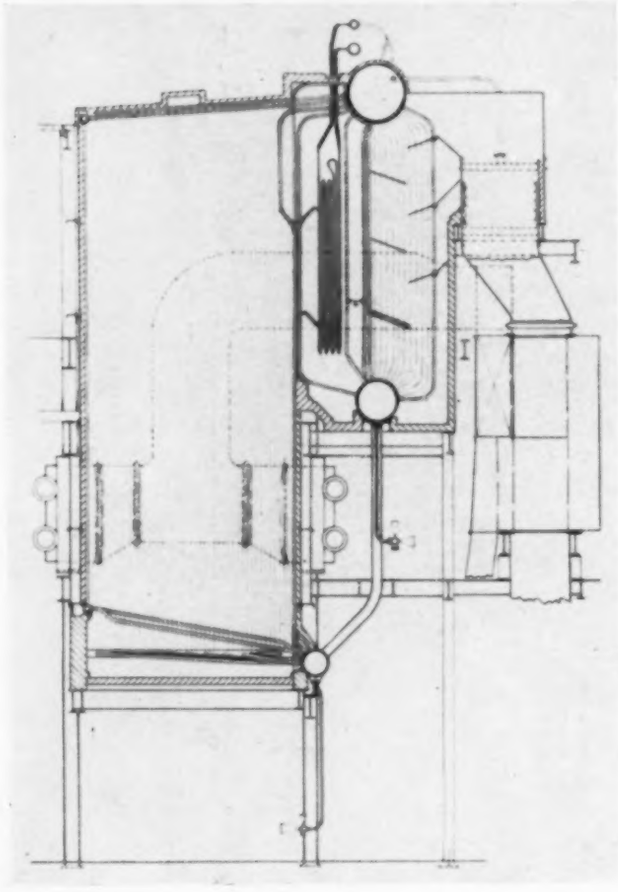


Figure 10 — Unit of 250,000 lb capacity for Bethlehem Steel Company at Johnstown, Pennsylvania. Blast furnace gas is the primary fuel.

to increase the availability and production rates to the maximum justified by economic conditions.

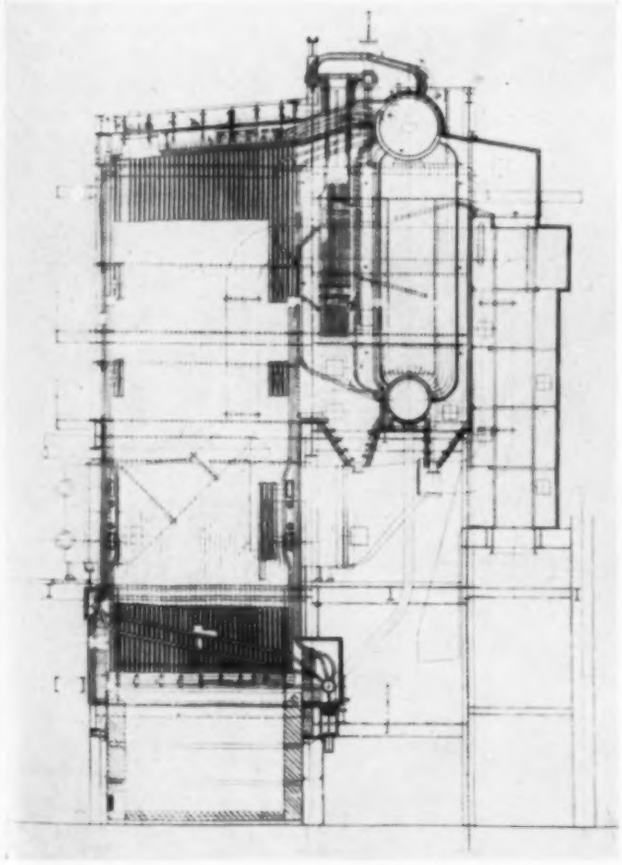
SOME LATE DESIGNS OF STEAM GENERATORS FOR THE STEEL INDUSTRY

Six units have been selected as examples of late designs of steam generators for the steel industry. The capacity of these units ranges from 325,000 lb steam

per hour for the largest, to 75,000 lb steam per hour for the smallest. The largest is designed to generate its steam at 900 psi gage and 900 F while the smallest is generating its steam at 250 psi gage and 545 F. The primary fuel in each case is blast furnace gas, with supplementary fuels of coal, oil, coke-oven gas or coke breeze.

The design of a unit for the Bethlehem Steel Company at Sparrows Point is shown in Figure 9. This unit is designed to produce 325,000 pounds of steam per hour at 900 psi gage and 900 F total temperature. It will burn blast furnace gas as the primary fuel with coke breeze on a chain grate stoker as a secondary fuel. The superheater is divided into a radiant section, and the normal convective section. The radiant section is shielded from the furnace by a two row screen of evaporating tubes and separated from the convective section by an additional two rows of evaporating tubes. The first screen is to chill any sticky slag in the gases so that superheater plugging will be minimized. To control the amount of superheat at several loads and with different proportions of the secondary fuel, the convective section of the superheater may be by-passed by the dampers after the main boiler section. The gas flow can be divided so that the proper portion by-passes the convective superheater and the total temperature is held constant. The air heater is divided so that part of the air supply is heated for the blast furnace gas and part is heated to a lower temperature for the coke breeze. An interconnection is provided so that the two sections of the air heater may operate as a unit or at intermediate mixtures up to the limit set by closing the damper on the interconnection. The stoker is well shielded by a long water-cooled rear arch so that the grate surface is protected at low rates of burning the secondary fuel. The high furnace provides a long travel for the stoker gases and sufficient travel for the combustion of the blast furnace gas. The use of the by-pass damper for superheat control compensates for the designer's inability to move the stoker, with its comparatively low volume of combustion products, nearer to the superheater. Although not clearly shown in the Figure three pre-mix steam atomizing oil burners are installed in each of the nine gas burners. When oil is not in use it is intended that some steam be passed through the burner for protection of the atomizing head. This unit is not yet in operation so field performance is not yet available.

Figure 11 — Unit of 150,000 lb capacity for Republic Steel Corporation at Youngstown, Ohio.



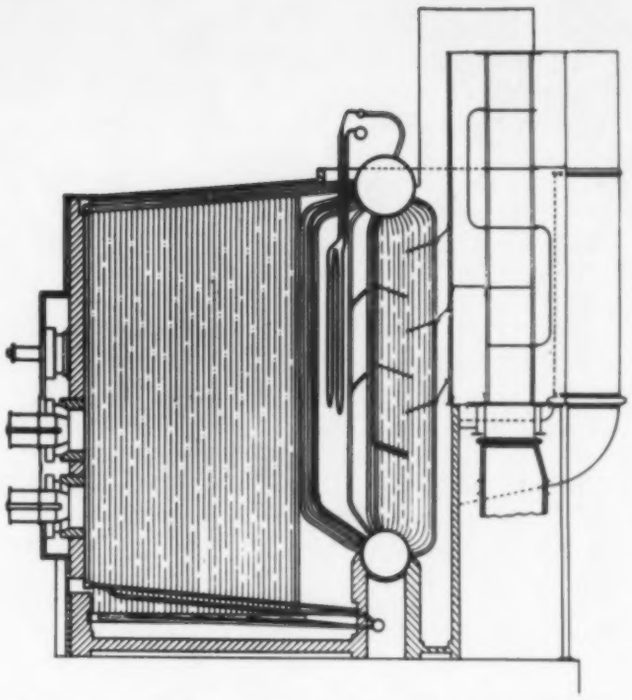


Figure 12 — Unit of 125,000 lb capacity for the Steel Company of Canada at Hamilton, Ontario. Primary fuel is blast furnace gas and secondary fuels are coke-oven gas and oil.

Figure 10 shows a unit being built for the Bethlehem Steel Company at Johnstown, Pennsylvania. It is designed for 250,000 lb per hr at 850 psi gage and 890 F total temperature. The unit will burn blast furnace gas with oil as the secondary fuel. In this design the gas is fired from each corner and directed to form a tangent to a circle in the furnace. Corner firing is used extensively in other industries and has been particularly successful in maintaining low carbon losses in the flue dusts from pulverized coal firing and practically eliminating the necessity for distributing fuel and air to each corner in the same ratio. The intense turbulence and mixing action in the flame corrects for any differences in fuel air ratio to each corner. In this installation the oil burners are installed between the two gas burners in each corner. Some of the wall tubes have been bent outward to provide, with a row of boiler tubes, a widely spaced slag screen in front of the convection super-

heater. A by-pass around the superheater is arranged for control to compensate for the proportion of secondary fuel and its possible effect on furnace cleanliness.

Figure 11 shows a unit for the Republic Steel Corporation of Youngstown. It is designed to produce 150,000 lb of steam per hour at 870 psi gage and 860 F total temperature. The primary fuel is blast furnace gas, fired from the corners, with oil as secondary fuel. The design is quite similar to that shown in Figure 10 except for the lower capacity and the somewhat lower temperature. The oil is fired from corner burners installed between the gas burners.

Figure 12 shows a unit designed for the Steel Company of Canada. It is to have a capacity of 125,000 lb of steam per hour at about 450 psi gage and 750 F total temperature with blast furnace gas. The secondary fuels are coke-oven gas and oil. The secondary fuels are fired through the three upper burners while the four lower burners are used for the primary fuel. The upper position of the secondary fuel burners brings them nearer the superheater with less furnace cooling surface available to reduce the temperature of the products of combustion than exists for the blast furnace gas.

The products of combustion for blast furnace gas have almost twice the volume of those for secondary gaseous or liquid fuels. The effect of this difference in volumes on convective heat transfer in the superheater has already been mentioned and in this case the effect has been partly offset by the location of the burners. In this case the desire for a high temperature preheated air has resulted in placing the economizer after the preheater.

Figure 13 shows another unit designed for the Steel Company of Canada to operate under the same capacity and conditions or pressure and temperature as that shown in Figure 12. The secondary fuel in this unit, however, is coke breeze. Attention is called to the shielding of the stoker by the water cooled arch and the exchange in the position of the economizer and air heater. This change indicates that the Steel Company of Canada considers coke breeze as the primary fuel in this case, and as the stoker does not utilize as high a preheat in the air supply the advantage of position is given the economizer.

Figure 14 shows the design of a unit for the Pittsburgh Coke and Chemical Company at Neville Island. This unit is operated at a capacity of 75,000 lb of steam per hour at 250 psi gage and 545 F total temperature. The secondary fuel is pulverized coal fired through the upper burners. Field operating experience with this unit has been very satisfactory particularly from the standpoint of availability. From the time of initial start until taken off for insurance and state inspection it was continuously on the line for the eleven elapsed months. During this period it generated 402 million pounds of steam from 100 per cent make-up feed water. The average load for the entire period was 50,000 lb steam per hour. Automatic control maintains constant steam pressure with widely varying supply of primary fuel.

CONCLUSION

Some of the factors which influence availability have been discussed in this paper. Slag has been examined in some detail and the control of its deposition is improving through the use of cooling screens, burner position, and perhaps the relation of the area of the flame envelope to the water-cooled area of the furnace. The use of effective shielding for uncooled parts has improved availability. Improved control of water conditioning is necessary as the design pressures and temperatures of steam generators rise. To meet load variations at high pressures, the designer must depend increasingly on the ability to change the heat input rapidly rather than on the flywheel effect of a large mass of boiling water. The application, within limits fixed by local conditions, of design improvements for increased availability is shown by six late designs of steam generators for the steel industry.

Figure 13 — Unit of 125,000 lb capacity for the Steel Company of Canada at Hamilton (with stoker).

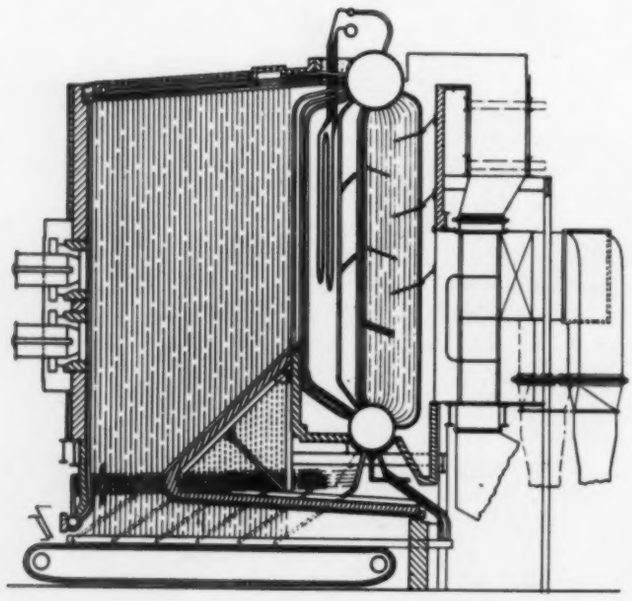
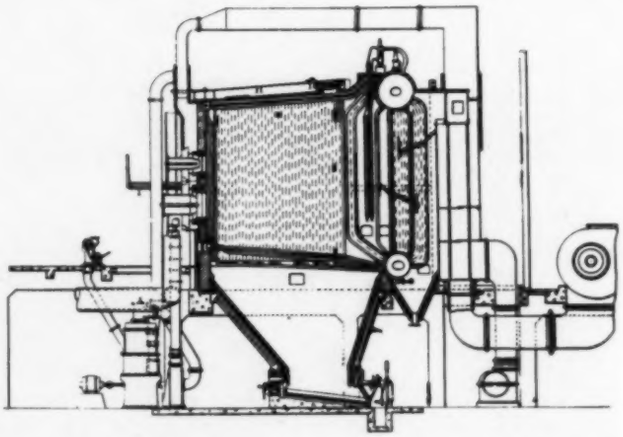


Figure 14 — Unit of 75,000 lb capacity for the Pittsburgh Coke and Chemical Company at Neville Island. Average load for first eleven months was 50,000 lb.



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DISCUSSION

PRESENTED BY

EDWARD W. FITCH, Chief Combustion Engineer, Republic Steel Corporation, Youngstown, Ohio

A. R. MUMFORD, Development Engineer, Combustion Engineering Company, Inc., New York, New York

C. J. WYROUGH, Assistant Superintendent, Maintenance, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania

J. M. SPENCER, Steam Engineer, Bethlehem Steel Company, Sparrows Point, Baltimore, Maryland

JOHN J. ALEXANDER, Assistant Superintendent, Power, Republic Steel Corporation, Cleveland, Ohio

Edward W. Fitch: Mr. Mumford stated that minerals in the coal ash combining with minerals in blast furnace dust cause the ash to become more viscous and adherent to the heating surfaces. I have heard other discussions in which it was claimed that the abrasive action of the coal ash helps keep the heating surfaces clean of flue dust deposits. I wonder if Mr. Mumford would discuss that any further.

A. R. Mumford: That is true, but if your gas velocities are high any dust in that gas is going to abrade whatever it hits. The desire is to keep that abrasion down in order to not cut your tubes. For instance, I have seen on an anthracite operation fired by a chain grate stoker, the fly ash from that fuel is highly abrasive, a 2 in. cast ring cut down flat to the tube. Similarly powdered coal ash, if the velocities are high enough, will cut through a superheater tube or a boiler tube ultimately, so the use of the abrasive power of the dust in the flue gases to cut down deposits seems to me to be a bit too costly. I would rather steer away from it in order to save the metal of the tube, because it will cut that just the same as the deposited dust.

The addition of iron will lower the temperature, make it sticky under conditions where it normally might not be, and cause it to adhere to the surfaces. The minute it does, you are going to lose the power of absorbing heat, as indicated in these charts, as much as 20 to 40 per cent of what a clean tube will absorb, and when you do that you unbalance the whole unit, because the heat that the designer expected to be absorbed in the furnace may be now absorbed elsewhere and the balance is destroyed, so your operation is up against difficulties.

The thing that puzzles me is that in a furnace fired by blast furnace gas and burning coal with it, even though the gas has been cleaned by electrostatic precipitation to a hundredth of a grain to a cubic foot, the combination firing causes three times as much deposit, took three times as long to clean, and burned up the grates at a much more rapid rate than in a furnace fired with coal alone. It seems a little difficult to imagine so little dust doing so much damage, but it did.

If you maintain your furnace so large that the rate of heat absorption is low, and keep the volume of flame less than the volume of the furnace, then you have a space between the flame and the walls through which the dust would pass before it hits the wall, and during which time it would have a chance to be frozen so that it would not adhere to the wall. In that way, you can keep your furnaces clean and you can keep your balance right.

C. J. Wyrough: Approximately ten years ago the cross drum, header, straight tube type boiler seemed to be most generally offered and recommended by boiler manufacturers. All the pictures of recent installations accompanying your paper showed multi-drum bent tube boilers. What is the chief reason for the change in design and will this be a permanent change?

A. R. Mumford: The cross drum, header type, straight tube boiler was offered for high pressures because of price. Mr. Wyrough is correct that some or all boiler manufacturers no longer offer that design. There are many reasons for this change, involving arrangement of surfaces, adaptability to available space, etc. I do not know that there is a chief reason applicable to all cases. An examination of modern high-pressure, high-temperature designs will show little convective surface between the furnace and the superheater, and as the amount of such surface decreases the applicability of header type construction disappears. For high absorption rates just above a furnace, the relief of the high headers to the drum requires almost as much tubing as does headerless construction so little saving is available. Today because of output and pressure temperature requirements, the original price advantage has become negligible or non-existent. One of the biggest changes in price has been caused by the advances in the art of welding which permitted the substitution of welded drums for forged drums for high pressure boilers.

J. M. Spencer: The author's remarks on slagging characteristics of mixed fuels are of particular interest to us at Sparrows Point.

The units illustrated in Figure 9 of his paper will be fired with wet washed gas containing 1/10 grains per cubic foot. Incidentally, the capacity of these units has now been increased to 400,000 pounds per hour.

F. X. Gilg, in his paper "Blast Furnace Gas — Wet

Washed or Dry Cleaned," 1945 Proceedings, Association of Iron and Steel Engineers has indicated that wet washing of blast furnace gas lowers the fusion temperature of the ash by decreasing the ratio of iron oxide to sodium sulphate. In our new installation, we have available about 2500 feet of gas main which will be used for wet washing of the gas by means of fogging type nozzles. Approximately half of the cleaning will be done with salt water containing 3500 ppm of chlorides, and the final washing will be done with fresh water containing 100 ppm of chlorides. The lower chloride water is being used to give a more favorable iron oxide to sodium sulphate ratio, and a consequent higher ash fusion temperature.

Several years ago, we substituted this low chloride water for salt water on our disintegrators supplying gas for the furnace stoves. This change effected a marked decrease in the slagging of the brick in the stoves, the change being attributed to the removal of the fluxing agent and the resulting higher fusion temperature of the brick. Recent work in England reported in a paper by Dr. H. E. Crossley of the Fuel Research Station of the Department of Scientific and Industrial Research, published in the August 1947 Combustion, would indicate that in some cases, the chlorides alone are responsible for slagging difficulties.

The effect on steam temperature of change in mass flow has been noted, as has the effect due to insulation of the boiler heat absorbing surface. The author's comments on the relative weight of these two factors would be of interest.

A. R. Mumford: Mr. Spencer's experience with the washing of blast furnace gas as a means of reducing the iron content is very interesting as is also the reference to the chlorides as being responsible for slagging difficulties. In the writer's limited experience, small quantities of iron will increase the tendency of coal ash to adhere and quantities existing in precipitator cleaned gas have been sufficient in one instance. Blast furnace gas alone or coal alone could be burned with comparatively little trouble, but combination firing did increase the difficulties in a furnace adapted for, but not originally designed for, the simultaneous burning of the two fuels.

The relative weight of mass flow versus insulation of absorbing surface is a question about which information is becoming available. In one case, an inch thick layer of non-vitrefied ash reduced the heat transmitted 70 per cent. An increase in mass flow of a proportion normally to be expected would not effect a corresponding change in heat absorption. In the writer's opinion a clean furnace is more important than a change in mass flow from a control standpoint. Certainly at maximum mass flow the furnace must be clean in order to offset both the effect of higher mass flow and higher temperatures leaving the furnace.

John J. Alexander: Mr. Mumford has enumerated and explained a number of design features that increase the availability of the modern steam generating unit. From an operating standpoint, I certainly agree that modern design units have a much higher availability factor. Our units installed in 1943 have been out of service only 96 hours (for repairs and internal inspections) during the past eighteen months. The service availability of the modern units is 99 per cent compared to 97.4 per cent for 250 psi units of somewhat older design.

I would like to ask Mr. Mumford what influence the operating pressure has upon the availability at the various pressures? The 250 lb, 545 F units shown in Figure 14 were operated for eleven months of continuous service. What period of operation is normally experienced with 100 per cent makeup when boiler pressure is 450 psi? What period is normal for 850 psi units?

A. R. Mumford: I do not believe we can state that there is a normal for any pressure. Your operating procedure must be handled more carefully and must be under more highly qualified technical control as your pressure goes up. Your internal temperatures are going up; your wall thicknesses are going up, and your tube metal is under a higher temperature condition. A deposit of dirt inside the tube from your water will raise that temperature fast and cause damage quicker at high pressures than it will at lower pressures.

We have operated boilers in the steam-heating industry easily for a year without damage with 100 per cent makeup. At 1400 psi pressure, I do not know of any boiler that is operating at 100 per cent makeup. I know of one that is operating at about 35 per cent makeup, not one but one plant, internally treated. That plant, of course, has pretty high technical skill and control and has relatively little damage. However, their turbines do require outages in order to maintain the maximum efficiency, and those outages take place perhaps every six weeks.

The boiler is completely inspected and overhauled once a year. The turbines are washed about every six weeks. That may not be considered a real outage, but, nevertheless, it is a drop in production, and I think as your pressure goes up you will have to watch the amount of makeup pretty carefully, because any slight deficiency in your chemical control of that water is going to give you a serious chance of burning out some part of the boiler. It does not take much of an internal scale at those high pressures to raise the tube metal beyond the temperature at which it will retain its strength. Normally, we do not like to see the surface of any tube go above 850 F, that is, ordinary carbon steel boiler tubes, which normally run about 750 F in a furnace.

I have seen some tubes momentarily go up to 1200 F without any apparent damage, but operators work pretty fast to get them down again, because one blow from a tube like that might lift the whole roof of the boiler.

I do not believe I can answer the question as to a normal period of service with 100 per cent makeup for boilers as the pressures go up. I think if you would eliminate the 100 per cent makeup, I would say that most boilers will operate a year, but as your makeup increases, your chemical department has to be on its toes to maintain the proper conditions in that boiler, or you will get into trouble quickly.

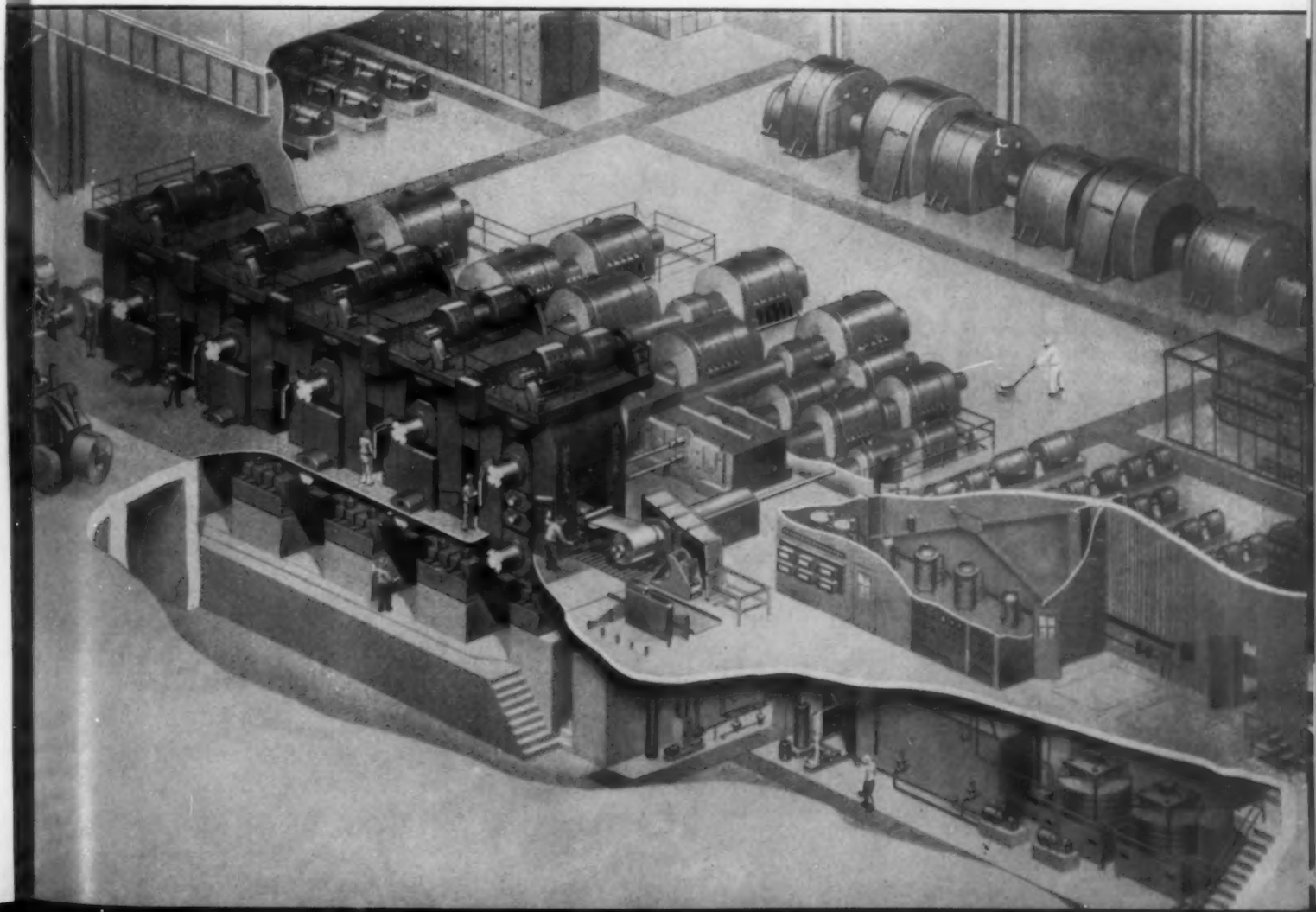
J&L ROLLS TINPLATE AT 70 MILES PER HOUR

▲ J & L, who first among the fully integrated independent steel companies, entered the tin plate business in 1910, has always been a prominent producer of high quality tinned and black plate.

In the 1930's, the traditional hot rolling of sheets for tinning in packs on two high jump mills was abandoned, and their job was picked up in part by a 4-high reversing cold reducing strip mill at Aliquippa tin mill, and mainly by a 54 in. four-stand mill at the Pittsburgh works. The latter is a combination mill for rolling strip to either the lighter tin plate gages or sheet gages, which are heavier.

The slabs of steel for tin plate are rolled to hot rolled strip on the 96 in. hot strip mill at the Pittsburgh works and have in the past been pickled in a continuous hot strip mill pickler there and either coated with a rust inhibiting oil for shipment to Aliquippa for cold reduction on the 4-high reversing mill, or coated with palm oil for cold reduction on the 54 in. four-stand tandem mill at Pittsburgh, after which they were shipped to Aliquippa for further processing along with coils from the Aliquippa reversing mill through annealing, tempering, electrolytic or hot dipped tinning operations, packaging and shipment. Electrolytic tinned plate is sheared after tinning and hot dipped before tinning.

Shipment of coils after pickling and before cold

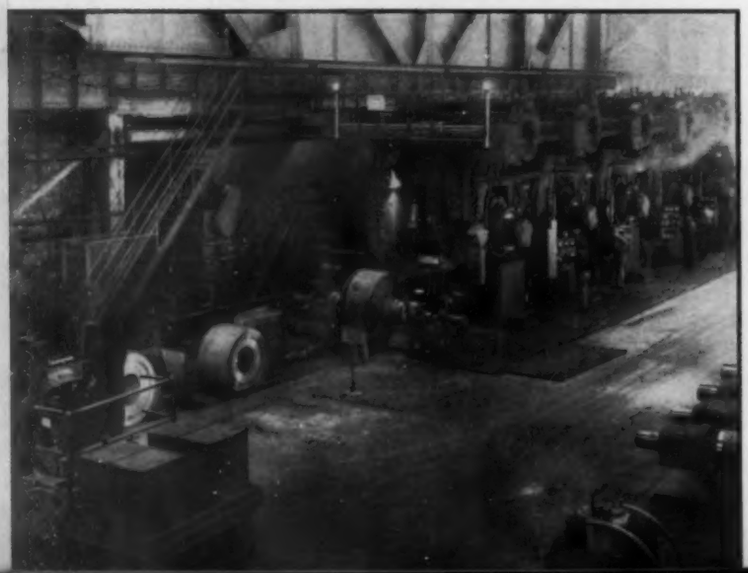


LEFT — The welding machine on the entry end of the new continuous pickle line welds into a continuous strip the hot rolled steel about to enter the pickle tanks. It has hydraulic feed and push up, and electronic heat control. CENTER — The steel strip rises from the looping pit and enters the first of four pickling tanks equipped with ducking rolls. Tanks are each 80 feet long and have 10 inch brick linings set in special high temperature resinous cement good for temperatures up to 250 F. RIGHT — Delivery end of the new continuous pickle line. At the end of the rinse tank in the pickle line is a high capacity drying unit to insure against any wet patches on the strip as it is coiled.

reducing or after cold reducing and before electrocleaning constitutes a break in the cold reduced strip processing cycle which is unfavorable from both a processing and a cost standpoint and, in 1945, the owners of the company again authorized a major change and costly investment. This involved the abandonment of pickling coils for tin plate at the Pittsburgh works, and rolling them on the Aliquippa reversing mill and the Pittsburgh four-stand tandem mill.

In the future coils for tin plate from the Pittsburgh works' 96 in. hot strip mill will be carefully cooled on a new hot coil conveyor about 800 feet long before shipment in the hot rolled condition to Aliquippa. This conveyor is to be installed at a cost in excess of $1,000,000

Coils of hot rolled strip from the new continuous pickle line, weighing as much as 30,000 pounds, are carried on a pallet type conveyor to a ramp, and fed into a hydraulically operated feed reel at the entry end.



and is designed to prevent edge or other damage to the hot coils coming from the mill, or baked-in scale while bringing the steel down to a satisfactory handling and shipping temperature.

The old hot mill group of buildings at the Aliquippa tin plate department has been revamped with many additions and an ultra-modern 42 in. five-stand tandem cold strip mill has been installed. The new mill is designed to embody the most favorable features for cold reducing strip for tin plate.

The new pickling line and the new mill have adequate capacity not only to fully serve the present cold strip finishing and tinning department, but also capacity to take care of a considerable future expansion of those departments. The pickler has a rated capacity of 50,000 net tons per month of pickled coils and the mill a rated capacity of 40,000 net tons of cold reduced coils per month.

The 42 in. continuous pickler is located just ahead of the mill and delivers coils of clean pickled strip adjacent to the entry of the mill. Units have been made of rugged construction for operation at high speeds and extreme service. Design is on the basis of pickling at a speed in excess of 400 fpm to meet the ultimate rated capacity of 50,000 net tons per month. Ward Leonard electrical control is used throughout.

The 6,000 or 7,000 lb coils are conveyed into the pickler and the 30,000 lb coils away from the pickler on heavy pallet type conveyors with the coils always on their round sides to prevent any damage to the edges of the strip. Each coil is weighed automatically without having to leave the conveyor.

The strip is fed from an expanding mandrel type feed reel into the especially rugged processor and without

the use of edge damaging side guides. This has two sets of breaker rolls and it has automatic hydraulic operation. Coil ends from the crop shear are disposed of by a convenient scrap handling car arrangement.

Coils are welded together by an electric flash welder of new design and powerful construction. This welder has hydraulic feed and push up and has electronic heat control.

The four pickling tanks, equipped with ducking rolls, are each 80 ft long and have 10 in. brick linings set in special high temperature resinous cement, good for temperatures up to 250 F. The tanks are served by a high capacity fume duct system. The pickled strip leaving the rinse tank goes through a high capacity dryer to insure against any wet patches on the strip as coiled.

Edges of the strip are slit, if desired, and the strip delivered in coils up to 30,000 lb in weight, coated with palm oil and ready for processing through the 42 in. high speed tandem mill.

The five-stand tandem mill is the most advanced mill that has yet been installed for producing quality cold reduced strip in tin plate gages and widths.

The mill will roll to minimum gages of 0.008 in. and less, and up to 36 in. wide from pickled hot rolled strip of up to 0.109 in. gage in coils that will finish 16 in. inside diameter up to 66 in. outside diameter maximum and up to 30,000 lb maximum weight.

The construction of this mill is the heaviest of any tandem cold strip mill for tin plate gages. The mill weighs 4000 tons and is placed on reinforced concrete foundations extending into bedrock 50 ft below ground level. The finished coils, almost 6 miles long and weighing 15 tons will be rolled under controlled tension and pressure conditions in about 5 minutes when operating at its unprecedented maximum nominal speed of 6000 fpm. Higher speeds have actually been attained.

The mill housings weigh 120 net tons each and have column sections 30 x 38 in. The driven work rolls are 21½ in. in diameter when new, with a length of face of 42 in. and are mounted in 4 row pin type tapered roller bearings. The backing up rolls are 53 in. in diameter with a 42 in. face and are mounted in oil bearings of 3,000,000 lb capacity each.

The screwdowns have 400:1 total ratio and are operated by two 75 hp motors, the largest capacity screw-down motors used by any tin plate tandem mill which are arranged for operation at over double voltage. The screwdowns on all stands have Ward Leonard control. They also have rotating type regulation for load limit control making their screw-down action the fastest in response and speed of any tandem mill.

Between each pair of stands is located an indicating electrical tensiometer as a guide in tension control. A tensiometer is also used after the fifth stand to indicate the pull on the strip by the tension reel.

Between the first and second stands there is a deep throat electrolimit gage or flying micrometer for automatic gage control of strip at this point. After the fifth stand there is an X-ray gage to measure the gage of the finished product.

The mill drives are unique. No. 1 stand has a conventional single motor drive through pinions. No. 2 has a double armature direct drive through pinions. No. 3 has a twin drive with a separate single armature motor independently driving each work roll through 1/1.525 ratio speed increasing gears. The No. 4 drive is similar

Roller is shown at his post between the first and second stands on the five stand tandem mill, Aliquippa Works, Jones & Laughlin Steel Corporation. The panel at the left regulates rolling speeds and controls the cold reduction of the steel strip as it passes through the mill. The panel at the right controls the second stand. Each stand has similar controls for stand operation.

This view at the discharge end of the world's fastest five-stand tandem mill shows the screw-downs at the top of the last two stands. These screw-downs have a 400:1 total ratio and are operated by two 75 hp motors.

Steel strip cold reduced in the five-stand tandem mill is coiled on the tension reel at the fastest speed for rolling steel in the world. The finished coils have a 16 inch inside diameter and up to 66 inches maximum outside diameter, and weigh up to 30,000 lb.

to No. 3 but with ½ ratio speed increasing gears. No. 5 has a twin drive with a separate double armature motor independently driving each work roll through ½ ratio speed increasing gears.

The two independent sets of speed increasing gears for each of stands No. 3, No. 4 and No. 5 are mounted in a common housing. This is of one piece casting construction with separate caps for each pair of gears. Gear diameters were held to a minimum and 3 bearing construction used to give maximum rigidity.

Data on the drives is given in Table I.

TABLE I

Stand	Motor hp	Motor rpm	Ratio drives	Speed fpm
No. 1	1750	80/240	1/1	450/1351
No. 2	3500	150/360	1/1	844/2026
No. 3	3500	175/350	1/1.525	1502/3004
No. 4	3500	200/400	1/2	2251/4503
No. 5	4000	275/535	1/2	3096/6023
Delivery reel	600	.....	.....	.....

While the total nominal capacity of these six mill and reel motors is 16,850 hp, a total of 20,100 hp can be carried continuously without overheating because of special insulation used.

This is the first five stand tandem mill to have separate drives on each work roll of the last three stands. Through motor design, twin drives and double armature motors, together with drive gear construction, it has been possible to produce a mill with low WK^2 (flywheel) effects thus permitting maximum rates of acceleration and deceleration. As a result, the mill can be accelerated from a threading speed of 300 to 4500 fpm in only 6 seconds. This saves time on the mill and more important still, reduces the amount of off gage strip resulting from speed changing conditions.

The mill is also unique in being the first tandem mill to go in with a separate generator for each stand. There are two main drive motor generator sets, each consisting of a 10,000 hp synchronous motor with 3 d-c generators. The three generators of one set serve stands No. 1, No. 2 and No. 3, and the other three serve No. 4 and No. 5 and the tension reel. The total kw generator capacity is 14,200 kw. This arrangement gives the maximum flexibility of speed matching for any desired rolling schedule within broad limits.

The separate generator scheme has several definite advantages over the older common bus scheme. First, it is possible to obtain ohmic drop compensation, so necessary on a high-speed tandem mill, without the use of the low voltage, high-current booster generators which it has been necessary to use with the older scheme of control. Second, the heavily supported high-current bus and the problems associated with it are eliminated. Third, adjustments between stands may be made by generator voltage control as well as by motor field adjustment, thus widening the operating range of each stand at the lower end.

In order to control the mill drives, the most modern type of controls utilizing rotating regulators have been installed.

Dissipation of the vast amount of energy of such a mill transformed through the work of rolling into heat makes necessary the use of great quantities of cooling water on the work rolls and back-up rolls, and generates great quantities of steam around the mill. In order to control and clear this situation, a fog elimination system was devised and installed which sucks the steam laden air away through a tunnel along the length of the mill, subjects it to condensing sprays in this subterranean duct and then discharges the air and residual water vapor to the atmosphere through two 80,000 cfm suction fans driven by 125 hp motors.

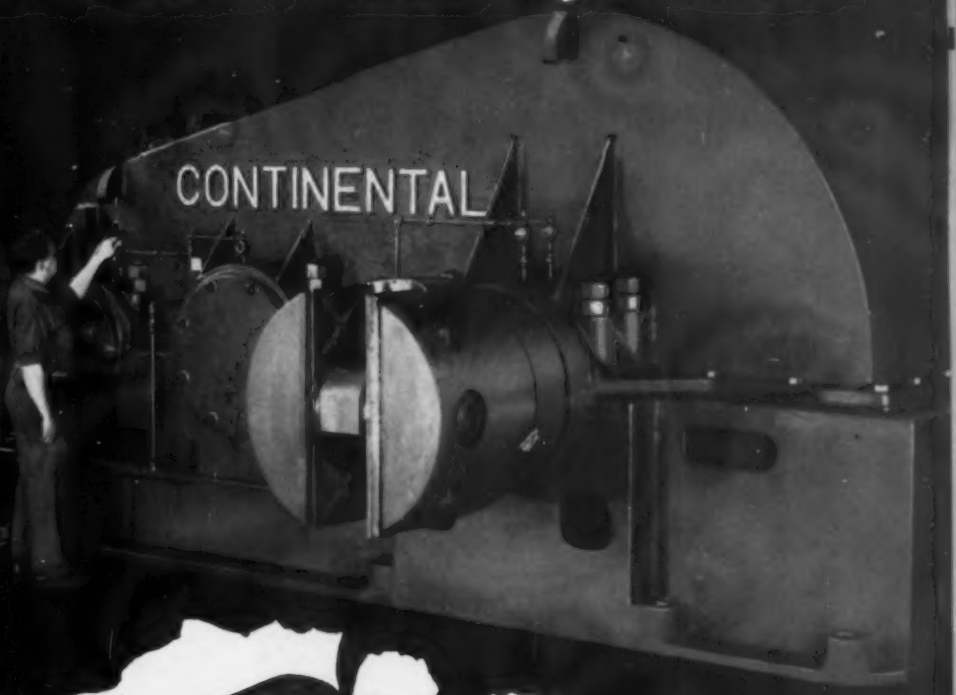
Another feature of cleanliness, as well as of modern reclamation, is doing away with conventional troughs under the mill for separating the palm oil used for rolling lubricant on the mill from the cooling water. Instead, the moisture is pumped as fast as it accumulates beneath the mill to an independent separation plant at high level in another building.

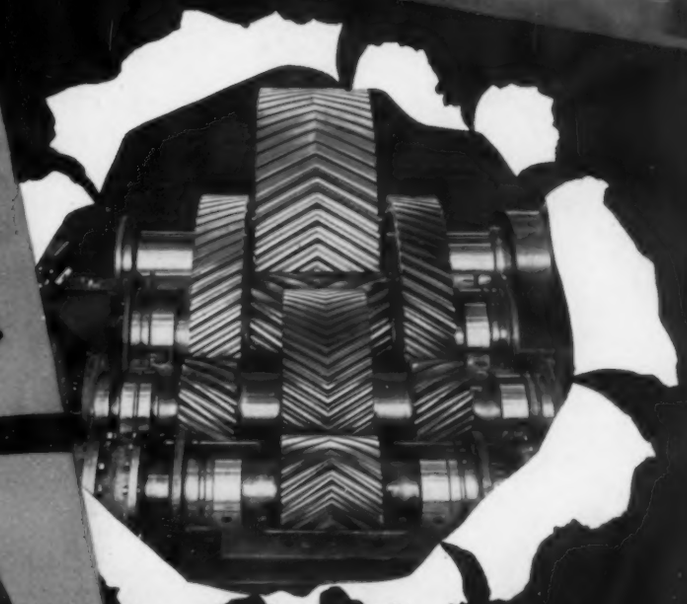
The new mill went into production in early October and the new pickler in early December of last year.

The mill drives, for the new five-stand are unique. No. 1 stand has a conventional single motor drive through pinions. No. 2 has a double armature direct drive through pinions. No. 3 has a twin drive through 1/1.525 ratio speed increasing gears. The No. 4 drive is similar to No. 3 but with ½ ratio speed increasing gears. No. 5 has a twin drive with a separate double armature motor independently driving each work roll through ½ ratio speed increasing gears.

gear drives

for HEAVY-DUTY MILL EQUIPMENT





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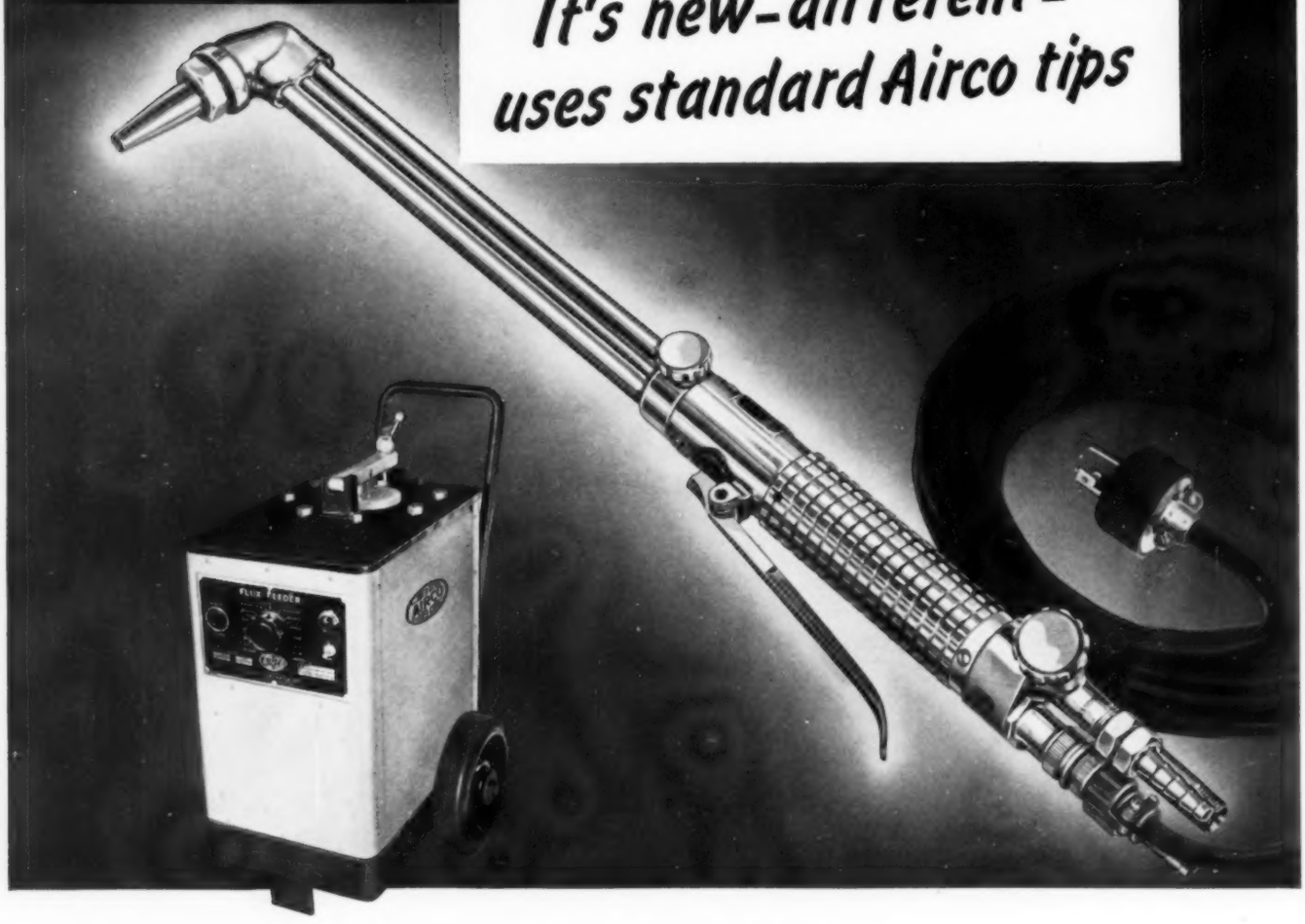
Iron and Steel Rolls
Carbon and Alloy Steel Castings

Now A torch for cutting stainless steel!

It's new–different– uses standard Airco tips



This new cutting torch, supplementing Airco's line of machine equipment, brings economical *manual* flame cutting of stainless steels within the scope of all types of mill and shop operations — makes it as easy to cut stainless as mild steel.

Designated in its 21″ length as Style 9016, this new torch is also available in a 36″ length. Both lengths come with a 90° torch head. In addition to a 25 foot electric cable, the outstanding features include:

1. Remote Control Cut-Off — automatically coordinates the flux feed with the cutting oxygen—eliminates separate flux control.
2. Uses Standard Cutting Tips — no special tips or attachments to buy.
3. Monel Metal Head — means durability — long trouble-free service.
4. Stainless Steel Tubes — which provide great rigidity and heat resistance.
5. Stainless Steel Lever and Ribbed Handle — designed to afford maximum ease of operation.

The new Airco 9016 uses the Flux-Injection principle. This Airco stainless steel cutting method feeds flux from a Flux Feeder Unit into the cutting oxygen stream. Thus, the flux is continuously and evenly dispersed throughout the entire cutting operation. The Flux Feeder Unit is portable, even when fully charged, so rapid movement from job to job is assured.

If you would like to have this torch demonstrated in your shop . . . or if you desire more information on stainless steel cutting in the form of a reprinted article; address: Dept. 8144, Air Reduction, 60 East 42nd Street, New York 17, N. Y. In Texas: Magnolia Airco Gas Products Company, Houston 1, Texas. On West Coast: Air Reduction Pacific Company, San Francisco 4, California. International Representatives: Airco Export Corporation, New York 18, New York.

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PRODUCT *Information*

ON ANY OF THE PRODUCTS MENTIONED IN THIS ISSUE

Below is an index of products referred to in editorial and advertising pages of this issue. If you desire additional information on any of them, use one of the accompanying postcards in requesting it. In each case give name of product and page number. The information will come to you directly from the manufacturer involved.

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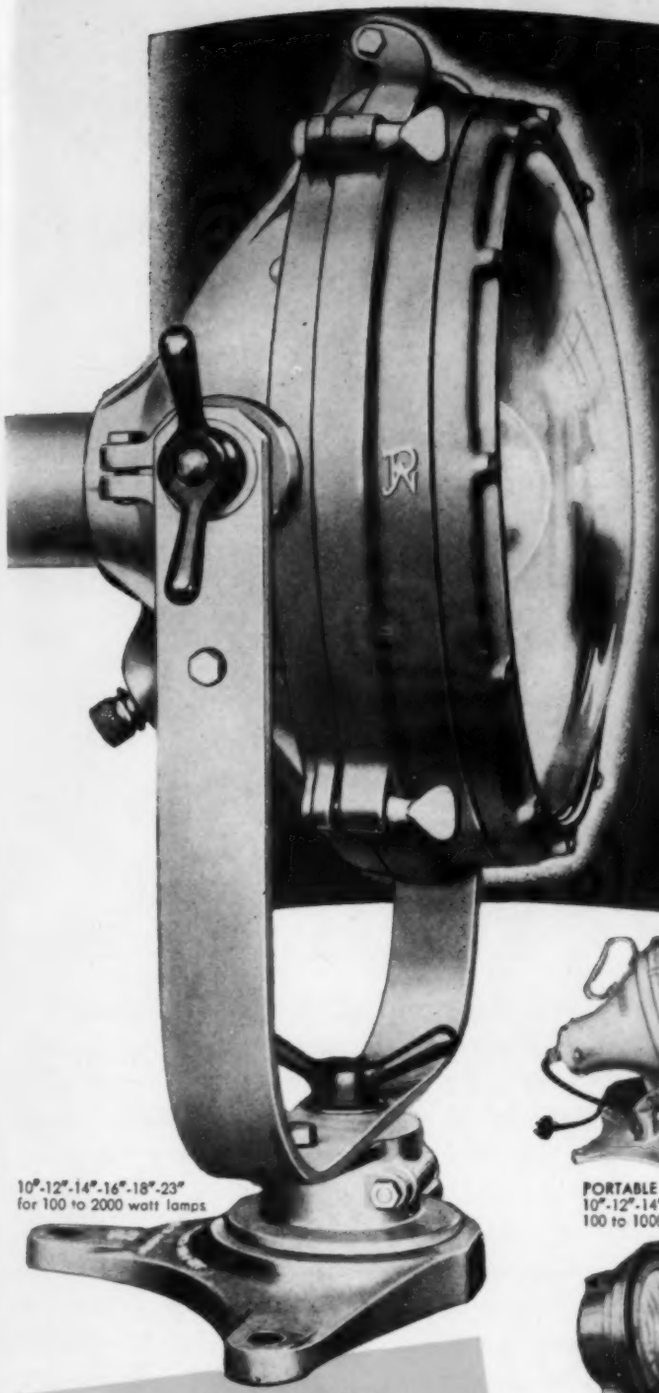

10"-12"-14"-16"-18"-23"
for 100 to 2000 watt lamps

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PYLE-NATIONAL FLOODLIGHTS

for Permanent Heavy-Duty Floodlighting

PORTABLE
10"-12"-14"-16"
100 to 1000 watts

FLUSH—10" for Pit or Subway Wall or Ceiling
100-150-200 watts

SHORT RANGE—10"-12"
for Wall Mounting
100-150-200 watts

Dependable Floodlighting with Minimum Maintenance

Pyle-National floodlight equipment is designed and constructed to withstand the most severe operating conditions. Complete range of types and sizes are available.

RUGGED cast aluminum housings with tight sealing doors and door glass joints—positively dust proof and moisture proof—give maximum protection to reflectors and lamps and reduce cleaning and other maintenance to an absolute minimum.

STRONG, galvanized cast iron bases and brackets of many types are provided for simple mounting and accurate adjustment in all locations.

ADVANCED DESIGN of the carefully molded and highly polished reflectors and lenses insure the highest optical efficiency—thoroughly annealed for maximum toughness.

Write for catalog 2100 giving complete information.

The services of our trained and experienced floodlighting specialists are available at all times to advise and assist in installation problems.

SINCE 1897

THE PYLE-NATIONAL COMPANY

1370 NORTH KOSTNER AVENUE, CHICAGO 51, ILLINOIS

Offices: New York • Baltimore • Pittsburgh • St. Louis • St. Paul • San Francisco • Cleveland

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Avoid Needless Losses
Due to Motor Burnouts
Protect Small Motors
As Well As Large Ones

with BUSS

Here's Proof That It Pays To Protect Small Motors

What is the FUSETRON?

The Fusetron is a DUAL element device — a Fuse to which is added a Thermal cutout.

The result is a fuse with tremendous time-lag and much less electrical resistance.

Fusetrons have the same degree of Underwriters' Laboratory approval for both motor-running and circuit protection as the most expensive devices made.

Made to the same dimensions as ordinary fuses, Fusetrons fit all standard fuse holders.

Obtainable in all sizes from 1/10 to 600 ampere in both 250 and 600 volt types. Also in plug types for 125 volt circuits.

Their cost is surprisingly low.

"In May, 1944, our progress in filling a contract for white uniforms was being seriously interfered with by motor burnouts and fuse blows on our power sewing machines. Each of these machines is driven by a half h. p. three phase 220 volt 2.3 ampere motor. Ordinary one-time fuses were then used. When the correct size fuse was used, it frequently blew when operators started their machines under load with the clutch out. Single phasing frequently resulted and then the motor was usually burned out before the fuse could be replaced. Our master mechanic was spending so much time replacing fuses that he began to use the maximum size he could get in the holder, 30 ampere, which, of course, resulted in still more burned out motors.

"About that time the President and General Manager of our company, wrote for information on Fusetrons. 2½ ampere Fusetrons were recommended. We had them installed at once.

"In July, 1945, our Superintendent reported that not one motor had been lost since Fusetrons were installed — and that the saving in man hours formerly wasted while burned out motors or fuses were replaced had helped us to fill our orders on schedule."

(*A large southern manufacturer—name on request*)

Fusetrons Prevent Shutdowns—Save Costs

The cost of installing Fusetrons is mighty small compared to the losses incurred when a motor burns out. You have not only the cost of removing and replacing the burned-out motor, but the cost of the shutdown as well.

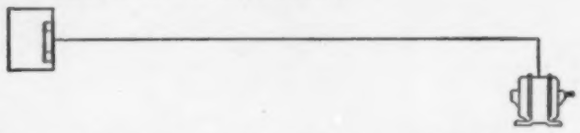
It will pay you to guard against these double losses by installing Fusetrons on small motor circuits such as pumps, fans, blowers, compressors, conveyors, mixers, grinders, stokers, oil burners — and hundreds of others.

FUSETRONS

Simple to Install

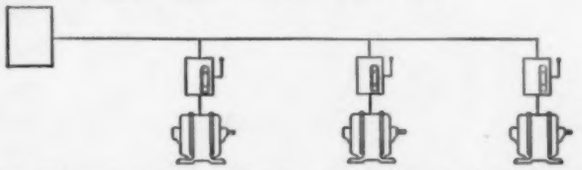
Just install a Fusetron of motor-running protection size anywhere in the circuit to handle only the motor current. Then on all normal installations, the motor will be protected against burnout due to lack of oil, worn bearings, tight belt, overloading — or anything that causes a dangerous excess of current through the motor.

If the motor is on a separate circuit,



a Fusetron of proper size in the switch or panelboard protects the motor and the circuit wiring.

If the motor is on a circuit feeding several motors,



install a Fusetron of motor-running protection size to protect each motor.

That's how simple it is to protect your motors from burnout — and yourself from losses due to motor burnout.

Fusetrons Give Many Other Kinds of Protection Heretofore Not Available

Fusetrons do everything fuses do, as is confirmed by Underwriters' Laboratories Label, and in addition . . .

* Entirely wipe out needless blows caused by motor starting currents or other harmless overloads. * Give Thermal Protection to Panelboards and Switches. * Lesser resistance means cooler operation and prevents needless blows caused by heating in panels and switches. * Permit use of larger motor or adding more motors on circuit WITHOUT installing larger switch or panel. * On new installations, PROPER size switches and panels can be used instead of OVERSIZE. * Protect small motors against burnout simply and inexpensively. * Give DOUBLE protection to large motors. * Provide simplest way to stop burnouts from single phasing. * Protect coils, transformers and solenoids against burnout.

Get All the Facts—Get Better Protection—Send the Coupon Now!

Even one lost motor, or one needless shutdown or one destroyed panel may cost you far more than replacing every fuse with a FUSETRON.

Don't risk such losses — protect yourself by changing over the fuses in your entire electrical system to FUSETRONS.

BUSSMANN MFG. COMPANY
University at Jefferson, St. Louis 7, Mo.
(Division McGraw Electric Company)

BUSS FUSETRONS—SOLD THROUGH WHOLESALERS

Bussmann Mfg. Co., University at Jefferson
St. Louis 7, Mo. (Division McGraw Electric Co.)

Please send me complete facts about BUSS Fusetrons.

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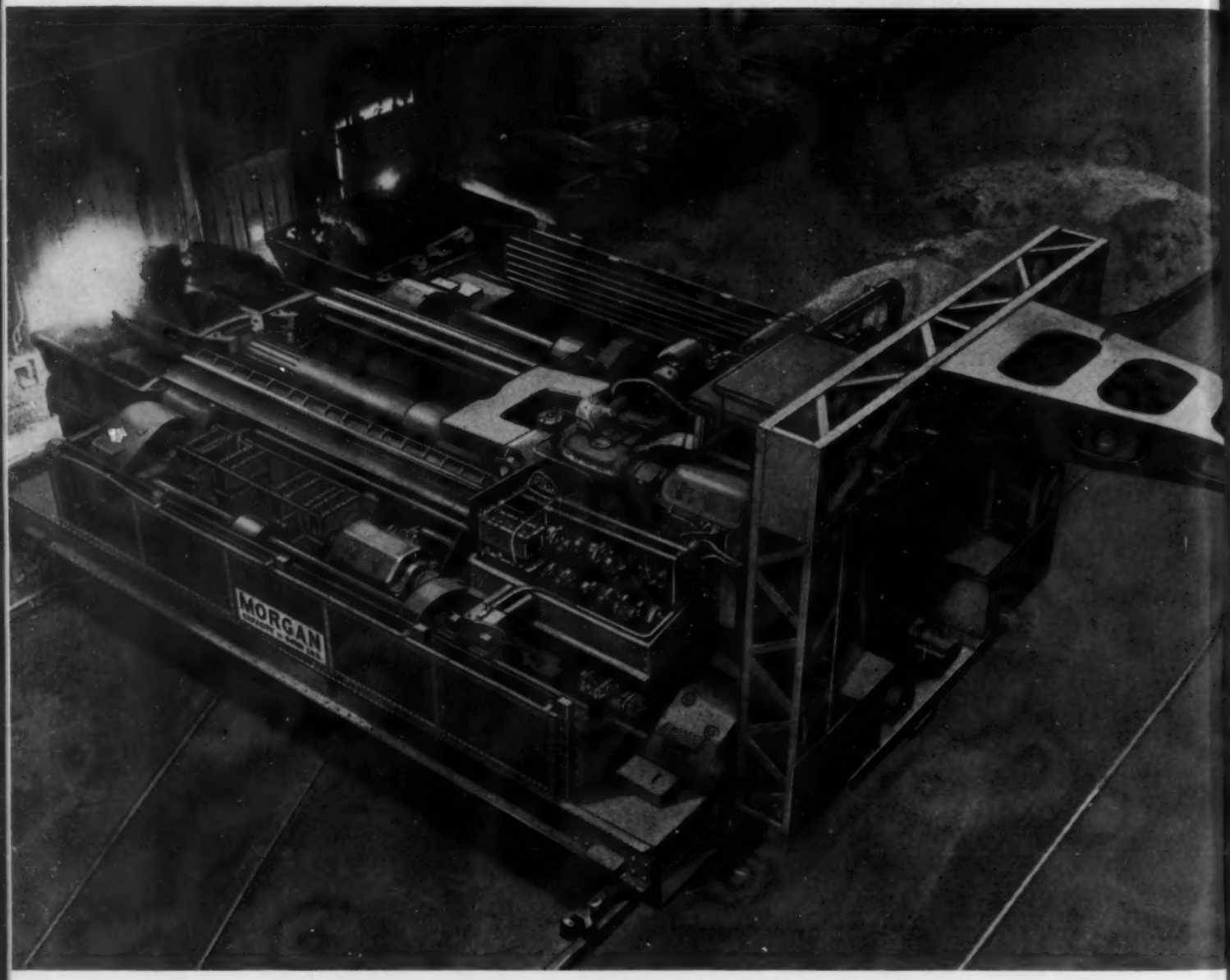
BUILT BY MORGAN Engineering

MORGAN 12-TON LOW TYPE OPEN HEARTH FLOOR CHARGER



Illustrated is one of three Morgan 12-ton 27'-0" span Box Chargers on this open hearth floor. Trolley frame is a one piece steel casting. Girders are of heavy box section. End carriages are of fabricated welded box construction. Roller bearings are used throughout. Entire machine is of massive construction especially designed for taking heavy thrust loads. Morgan Chargers are built in a wide variety of sizes in both the low and high type to meet varied charging floor requirements.

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NEWS SUPPLEMENT FEBRUARY, 1948

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Iron AND Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

CARNEGIE-ILLINOIS CHEMIST IMPROVES METHOD OF MEASURING CARBON CONTENT

▲ An improved technique for rapid determination of the carbon content of steel by the combustion method has been developed by H. J. Wolthorn, chief chemist at the Youngstown district works of Carnegie-Illinois Steel Corporation, in Youngstown, Ohio. Perfected at this United States Steel Corporation subsidiary plant, the method is carried out at a temperature of 1100 C (2012 F) — about 60 C higher than the former combustion procedure used for carbon analysis.

Three electrically heated furnaces, using non-metallic resistor heating elements, are each equipped with two silica tubes, so that a series of six samples can be undergoing test at the same time. The furnaces are arranged in a compact group, side by side, with their fronts aligned, as shown in the photographs. Rated at 1.4 kva maximum input, the furnaces are controlled by individual ammeters and temperature indicating instruments (millivoltmeter type), with transformer switching means that provide power input at between 45 and 190 volts in 5 volt steps. The silica tubes are 36 in. long, and 1 in. inside diameter.

Samples of steel for analysis are approximately 1⅓ grams, their exact weight having been chosen as half the factor weight to simplify calculation. Equipped with a visual aid, the chemical balance employed in weighing operations can be read with comparative ease to the fourth decimal place, reducing operator fatigue and increasing accuracy.

Kaolin clay boats are used to contain the samples during testing. Each boat is used for two individual tests, the first sample being placed in one end of the boat, and the second in the opposite end. Use of the clay boats and elimination of bedding material for the sample has increased accuracy of carbon determinations by reducing chances for contamination.

Simplified preparation of samples, plus the higher test temperature used, has reduced the time for individual tests from an average of 10 minutes to 8 minutes. The average number of tests is 180 every 8 hours for the three double-tube furnaces, using two operators. The balance operator confines his efforts to the required weighing operations and supervision of the order of charging the samples into the furnace tubes. His assistant merely places the weighed samples in the porcelain boats, charges them into the proper furnace tube, and removes them after each test is complete. An individual timer for each furnace tube is placed within easy reach and sight of the balance operator.

Oxygen is supplied to the silica tubes in the furnaces from a manifold

View of the rear ends of the carbon analysis furnaces, showing the effluent drying towers and the carbon dioxide absorption bottles which are weighed before and after each test to determine the weight of carbon dioxide formed and thus provide a basis for calculating carbon content of the steel sample being analyzed. Note timers above the absorption bottles which control duration of the tests. The chemical balance at the right is used to weigh samples of steels to be tested and the absorption bottles. The equipment is installed in the Youngstown District works of Carnegie-Illinois Steel Corporation, a United States Steel Corporation subsidiary.

that carries the gas to all six tubes. Before entering the manifold, the oxygen is passed through a soda-lime tower which removes carbon dioxide from the gas. A mercury manometer indicates the pressure, and consequently the flow rate, of oxygen to the manifold.

Contained in its clay boat, the sample is pushed into the silica tube to come to rest in the high temperature zone of the tube, and the oxygen connection is made to the tube. Oxygen flowing through the tube combines with the carbon in the steel at this high temperature to form carbon dioxide. The effluent from the combustion tube is led into a column containing manganese dioxide in its upper third to absorb sulphur in the gas, and magnesium perchlorate in the bottom two-thirds to absorb water vapor.

From this column, the gases are led to the weighing bulb, which contains magnesium perchlorate in its upper third and a mixture of commercial lye shaken with iron ore in the bottom two-thirds to absorb the carbon dioxide in the gas. Absorption of carbon dioxide by the reagent in the bulb increases the weight of the latter, and this increase in weight forms the basis for calculation of the amount of carbon in the sample, expressed as per cent. The iron ore in the weighing tube acts as an indicator to show when the absorbent needs replacement with fresh material. A rotameter type instrument measures the rate of flow of effluent gases from the weighing tube after the carbon dioxide has been absorbed.

This simplified absorption train reduces the number of rubber connections required by former trains of greater complexity, thus reducing chances of leakage and error.

TAGGING UNIT FOR BILLET IDENTIFICATION

A new metal tagging and tag embossing outfit, primarily designed to provide a permanent and more efficient method of identifying billets during storage in yards prior to the rolling operation, has been developed by M. E. Cunningham Company. In operation, interchangeable embossing type is quickly set up in the embossing unit. After embossing with a light hammer blow, the tag is placed in a fixture which bends it to fit over the hammer face and into the hammer clamps provided, at the same time punching a special heat treated nail through the tag. The hammer used with the tagging outfit is a regular three pound safety engineer's style tool. By swinging the hammer in the customary manner, the nail is driven into the steel billet, permanently attaching the tag for quick, easy identification.

COATING FOR METAL REMOVED WITH EASE

▲ A new protective coating for metal parts, which can be easily and quickly peeled off after it has served its purpose, has been developed by the Watson-Standard Company. "Peelcote" is an air-drying coating designed to protect from scratches, chips and corrosion during shipment, storage, handling and some types of fabrication. It can be applied by spray or dip methods and dries quickly. It is removed quickly and cleanly simply by pulling it off.

The coating is vinyl-based with complete chemical inertness. It is available in clear transparent or solid hiding black.

U. S. STEEL INCREASES RATED ANNUAL CAPACITY

▲ Benjamin F. Fairless, president of United States Steel Corporation, stated that as of January 1, 1948, United States Steel had a rated annual capacity for the production of steel ingots and castings amounting to 31,226,200 net tons. Mr. Fairless pointed out that this capacity represents a net increase of 3,431,200 tons, or 12.3 per cent, since January 1, 1940. The corporation's rated annual blast furnace capacity at January 1, 1948, amounted to 24,860,500 net tons of pig iron and other ferrous products, a net increase in the past eight years of 2,494,700 tons, or more than 11 per cent.

The foregoing figures do not include 300,000 net tons of additional steel producing capacity and 1,000,000 tons of additional blast furnace capacity which are now in course of installation by United States Steel.

Mr. Fairless explained that United States Steel actually had added 7,537,600 net tons to its steel producing capacity during this eight year period, an increase of 27.1 per cent. He added that the corresponding increase in blast furnace capacity during this period was 5,932,500 net tons, or 26.5 per cent. Thus United States Steel has increased its basic productive capacity by more than one-fourth during the war and postwar years.

The foregoing net increases in capacity represent smaller tonnages than these actual additions largely because obsolete facilities were taken out of production following their intensive

What OXYGEN Supply Will Be Used In Steel-Making Furnaces?

EXPERIENCE ALREADY GAINED shows that there will probably be more than one form of oxygen supply required for steel-making furnaces, when this product comes into regular use in making steel.

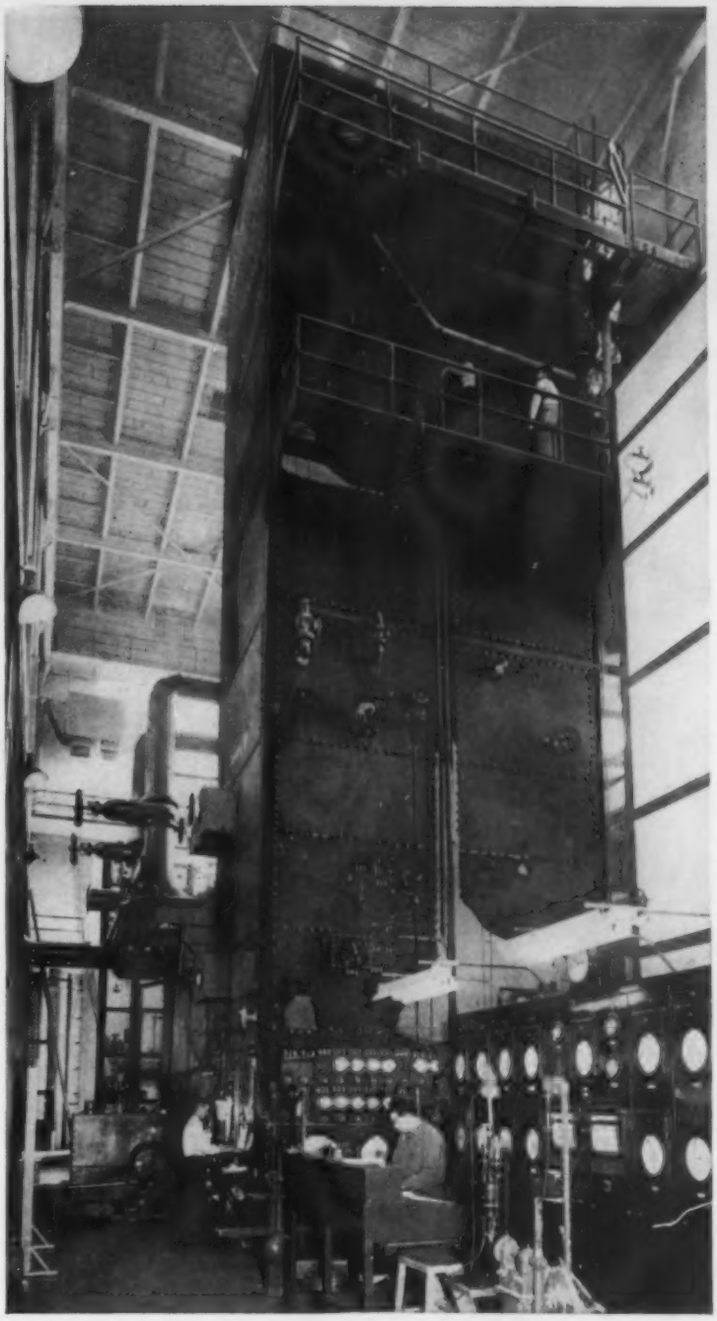
DATA FROM 8,000 HEATS, USING OXYGEN, run in 45 steel mill and furnace shops with which LINDE has been co-operating already have served to dimension the problems of furnace operation with oxygen. Meanwhile, consumption of oxygen per ton of steel has been reduced to a fraction of that frequently used a year ago to accomplish the same results.

This work has shown that some mills may accomplish much of the speed-up of furnace operation with *compressed air*—combined with some use of *high-purity oxygen*. In other mills, the operating practice and type of products made may call for a steady flow of tons of *low-purity gaseous oxygen* each day.

LINDE'S DRIOX liquid oxygen system long since has proved to be the obvious answer wherever substantial volumes of high-purity oxygen are required, and wherever dependability and flexibility of the system of supply are of prime importance.

Anticipating the demands for any desired quantity of low-purity oxygen, LINDE has had its huge low-purity oxygen plant in pilot operation for more than a year. This plant is an achievement resulting from 40 years experience in oxygen manufacture, and 15 years experimentation with low-purity units.

Steel mill management is thus in a position to benefit, regardless of the quantity or purity required, from LINDE's long-demonstrated experience with both *high-purity* and *low-purity oxygen* production—and outstanding success in saving money for its customers in any oxygen-using process.



The largest single column for producing gaseous oxygen ever constructed—200 tons per day of 90 per cent purity. First operated more than a year ago.

LINDE service engineers, through their experience with oxygen-using processes, can be of real assistance to you in studying the problems associated with obtaining increased production from the use of oxygen at your plant. Contact the nearest LINDE office.

Linde
Trade-Mark

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

30 E. 42nd St., New York 17, N. Y. UCC Offices in Other Principal Cities

In Canada: DOMINION OXYGEN COMPANY, LIMITED, Toronto

The words "Linde" and "Driox" are trade-marks of The Linde Air Products Company

use during World War II, and also because further facilities were sold by United States Steel to other steel companies. These last mentioned facilities, having an annual capacity of 1,292,000 net tons of steel and 1,841,100 net tons of pig iron, have not been lost to the country, as they now are being operated under their new ownership.

The increase in the rated annual steel ingot and castings capacity of United States Steel since January 1, 1947, amounts to 1,679,000 net tons.

THREADLESS FITTING REDUCES PRESSURE LOSS

▲ The Flagg-Flow threadless fitting is a black, malleable iron socket type fitting for brazing to steel or wrought iron, designed to meet the increasing demand for threadless fittings and also fittings without a chamber. The cup of this fitting is reamed to accommodate the outside diameter of standard pipe and also to produce a shoulder or stop for the pipe when it is inserted. Close tolerances in the machining of the cups insure rigid support and a thorough bond.

In a piping system using these specially designed fittings, pressure loss due to friction and turbulence is materially reduced.

There is materially less pressure loss due to friction and turbulence in a piping system using these specially designed fittings than in a similar system using threaded fittings. This reduced loss is particularly marked when handling viscous or semi-solid fluids, and the design of the fitting reduces the effects of turbulence in the pipe and fitting.

The fitting permits the utilization of the full wall thickness, and, therefore, the full strength of the pipe, since no metal is lost by threading. This eliminates the acknowledged weakness of a screwed pipe and fitting installation, and provides an opportunity for reducing, eventually, the wall thickness of the pipe.

One of the disadvantages of a threaded joint is that if it is improperly made, it will leak. It is also subject to corrosion, and the mechanical difficulty of joining an intricate pipe system with threads placed limitations on the use of pipe in out-of-the-way places until the advent of welding. With welding, it was possible to make a "one-piece" system without joints, which is considered ideal.

Welding is a comparatively new art and is expensive since it requires special skill not found in the average pipe fitter. Therefore, except for special jobs, largely in pipe sizes about

PICK THE RIGHT BUCKET

THIS CATALOGUE HELPS!

With hundreds of Blaw-Knox Buckets to pick from, it is easy to select exactly the right one for your conditions if you use Blaw-Knox Catalogue No. 2002. It lists factors to be considered and illustrates typical methods of installation.

The two-line hook-on type shown is one of those particularly adapted to slag handling in open hearth service. Other types, sizes and variations are described.

BLAW-KNOX DIVISION
OF BLAW-KNOX COMPANY
2015 Farmers Bank Bldg., Pittsburgh 22, Pa.

BLAW-KNOX CLAMSHELL BUCKETS

put your Btu's in shirtsleeves

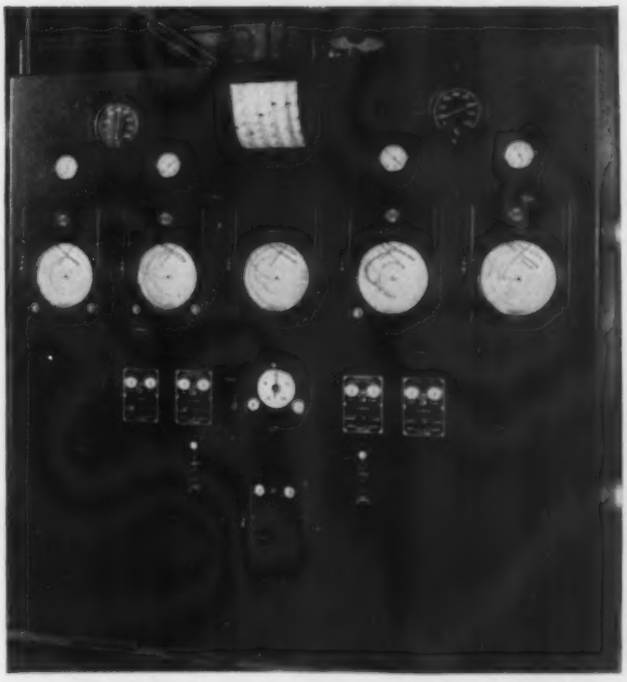
You can't have low power costs unless the Btu's you feed your boiler roll up their sleeves and go to work. They all won't anyway. The job to do is to put as many to work as possible. Then you get low power costs. And that is exactly what the Bailey co-ordinated boiler control system is designed to do.

This system reduces fuel consumption per pound of steam generated. Combustion, feed water, steam temperature, heater levels, pump speeds and all other factors are co-ordinated. Safety of operation is increased—continuity of service is improved.

You put the maximum number of Btu's to work in power and get all the efficiency your boiler was designed to deliver.

But remember this. The Bailey system is not delivered as a standard package. Each one is designed and engineered to the specific job on which it is to be used. That's why it functions so efficiently.

If you are looking for low cost power, it will pay you to call our nearest office.



Bailey Boiler Panel for a co-ordinated system of Combustion and Three-element Feed Water Control on a 450 psi, 120,000 lb. per hr., gas-fired boiler.

BAILEY METER COMPANY

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Controls for Steam Plants

COMBUSTION · FEED WATER · TEMPERATURE

PRESSURE · LIQUID LEVEL · FEED PUMPS

A-103

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Slowly revolving outlets distribute the heated air continuously downward in a constantly changing direction, completely and thoroughly covering the working area

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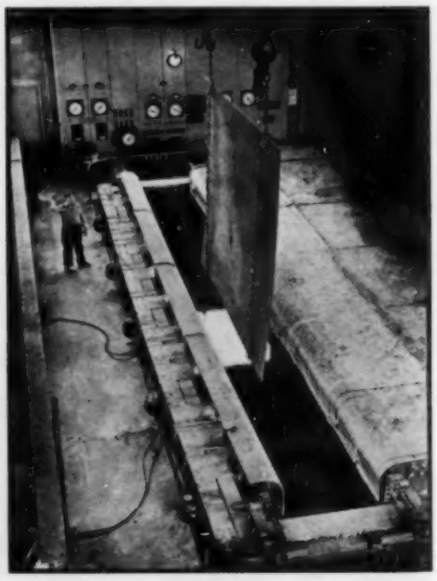
three inches, very little welding has been done until now. About 20 years ago, manufacturers of brass and copper tubing developed a method of joining pipe by soldered fittings, some of them being capable of using silver brazing alloys of considerable tensile strength. Today, then, there are three general types of piping installation: the ordinary screwed pipe job made with threaded malleable fittings and steel or wrought iron pipe; the welded job made with larger sizes of steel pipe or with copper or brass tubing, and the soldered job.

In effect, the new fitting bridges the gap between a threaded steel job and an expensive welded or soldered steel or copper job, as connections can be made by using silver brazing alloys.

LUKENS SOLVES SCALE REMOVAL PROBLEM

▲ The problem of removing scale from their hot-rolled clad plate and sheet, including stainless, nickel and monel, was recently solved at Lukens Steel Company, Coatesville, Pennsylvania, by the adoption of the molten salt bath descaling process. This system supplanted the old acid pickling process for removing scale and has already shown many technical and economical advantages. There is a great savings in metal since the salt bath treatment removes only the scale and does not attack the base metal. Time required to remove the

Work to be cleaned is placed on racks in such a way that all surfaces are reached by the bath.



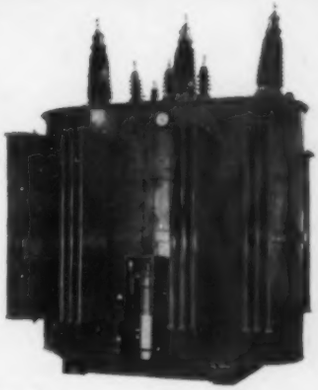
Pennsylvania
... an important name in transformers

It's a fact that Pennsylvania Transformers are making friends all over the country by giving good, honest service. We believe one of the major reasons for this is the special emphasis placed by Pennsylvania on research and development work, which has resulted in the introduction of many important improvements, such as the Straight Line Tap Changer, Uni-Row Radiators, and Precompressed Coils.

If you are in the market for transformers, you'll do well to consider Pennsylvania. The Pennsylvania Representative nearest you will be glad to review your transformer problems and discuss Pennsylvania's complete line of Distribution and Power Transformers.

3 Kva. Typical through 25 Kva.

DISTRIBUTION
3 Kva to 500 Kva. Up to 66,000 volts.

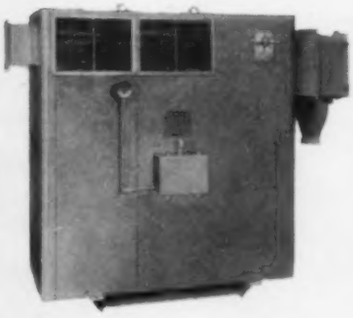


7500 Kva, 3 Phase, 60 Cycles 115,000-34,500/19,-900 volts.

POWER
667 Kva to 50000 Kva. Up to 165,000 volts.

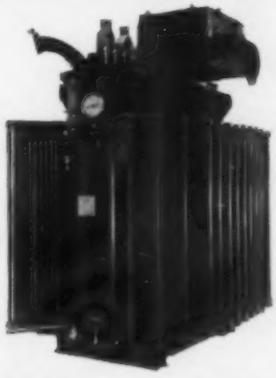
15,000 Kva with motor operated tap changer.

FURNACE
Up to 20,000 Kva



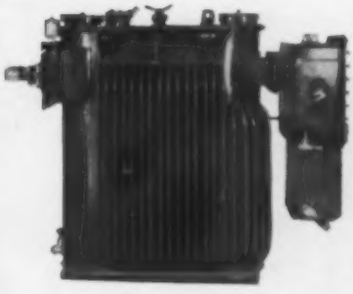
1000 Kva, 3 Phase, 60 Cycles 12,000-480 volts.

DRY TYPE
Natural and Forced Air Cooled.



3000 Kva, 3 Phase, 25 Cycles 13,800-480 volts.

ASKAREL
Distribution and Power sizes.



450 Kva, 3 Phase 22,000-208 volts.

NETWORK
Indoor or street vault installation.

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of our eight page booklets, "4 Minutes with Pennsylvania Transformers", "Ask for Askarel".

Pennsylvania
TRANSFORMER COMPANY
PITTSBURGH, PENNSYLVANIA

Pennsylvania TRANSFORMERS

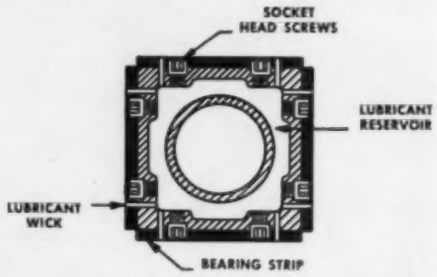
scale has been materially reduced while at the same time a more uniform descaling has resulted without pitting or hydrogen embrittlement.

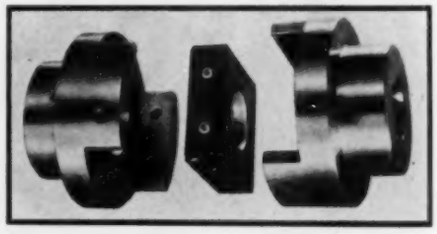
The new salt bath process involves an Ajax Hultgren electric salt bath furnace. The bath, consisting of molten sodium hydroxide with the addition of sodium hydride, has working dimensions of 40 ft in length by 4 ft in width by 11 ft 6 in. salt depth. So far as is known, this is the largest salt bath ever constructed. It has a power input of 800 kw and is heated by the immersed electrode principle. The furnace holds 165 tons of salt and was designed and manufactured by the Ajax Electric Company.

The descaling process is extremely simple. Work to be cleaned is merely placed on suitable racks in such a way that all surfaces are reached by the bath. The pieces are held in the bath, which operates at 700 F, until the reducing cycle is completed. This time varies from 8 to 20 minutes depending on the thickness and weight of the plates as well as the particular type of metal or alloy being cleaned. After the scale is completely reduced and while the work is still hot, it is immersed in water which removes a large portion of the reduced material. A high pressure water rinse removes any loosely clinging material as well as all traces of caustic soda. This is followed by a flash dip in acid to produce bright surfaces and is followed by another high pressure rinse to remove any traces of smut or acid remaining on the work. Although this molten salt bath descaling process is new with Lukens, it is similar to that used by several of the stainless steel mills for the past several years.

BETTER DESIGN IMPROVES COUPLING WEARABILITY

▲ A recent design improvement has increased the wearability of the American Flexible Coupling as much as 30 per cent, according to an announcement made by the manufacturer on the basis of tests. The only part that absorbs wear in these couplings is the center member or block which has a free sliding action between the two jaw flanges of the coupling. This center member is faced with bearing strips which are the points of contact with the jaw flanges. The center block was recently improved so that the bearing strips now slide upon the center block to which





they are secured. This greatly reduces the friction which results between the bearing strips and the flanges as the coupling rotates.

This coupling is based on the Oldham principle. Each of two jaw flanges, mounted on the shafts, engages opposite parallel surfaces of a square center member, the engaged surfaces of each being at right angles. The center member slides between the two integral jaws of each jaw flange in directions relatively at right angles as

"RODINE" is used effectively in continuous as well as in batch pickling.

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RODINE* -- saves metal -- controls acid attack -- minimizes over-pickling and hydrogen embrittlement -- prolongs life of the acid bath -- saves acid -- holds down fumes -- facilitates scale removal. Just add a little to the Sulfuric or Muriatic acid bath -- For better pickled surfaces -- speed -- economy -- use "RODINE"

Send for full list of ACP metal treating chemicals--of interest to all processors of iron--steel--aluminum and copper products.

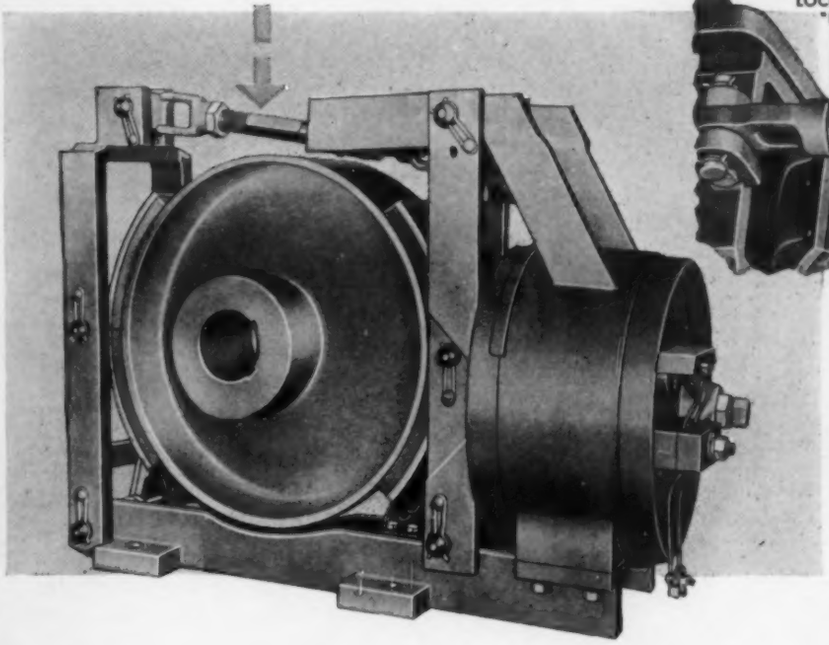
AMERICAN CHEMICAL PAINT CO.
AMBLER ACP PENNA.

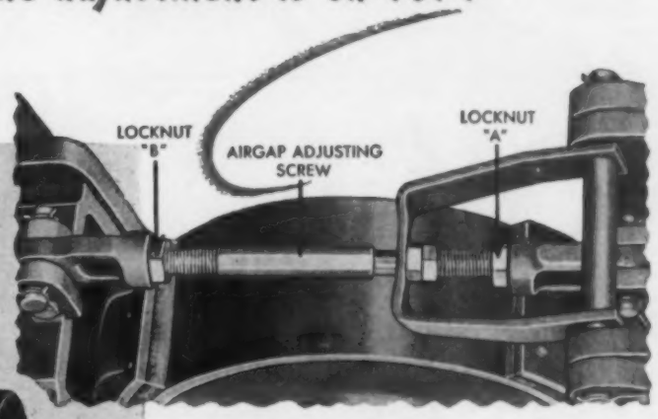
ONE and ONLY ONE ADJUSTMENT NEEDED

FOR LINING WEAR with

CLARK Bulletin 106 DC SHOE BRAKES

—and that one adjustment is on TOP!





TOP view of Clark Bulletin 106 DC Shoe Brake showing visibility and ease of adjustments

Side View of Clark Bulletin 106 DC Shoe Brake

When linings are worn, it is only necessary to loosen two locknuts, turn one adjusting screw bar (tie-rod) and when setting is reestablished just re-tighten the locknuts.

The setting is indicated by the visual indicator, easily seen on the TOP of the Brake—not on the bottom, not on the sides, but on TOP—where there's nothing to interfere with examination or correction. This is the only maintenance adjustment needed on CLARK Bulletin 106 Brakes. *Here is simplicity that counts!*

The tie-rod is high-tensile strength non-ferrous metal, thus preventing "freezing of nuts" by rust or corrosion.

For heavy duty applications such as crane hoists, screwdowns, general mill auxiliaries, etc., to stop a DC motor quickly and smoothly without severe shock to connected mechanisms, use CLARK, Bulletin 106 Brakes.

THE CLARK CONTROLLER CO.

EVERYTHING UNDER CONTROL • 1146 EAST 152nd STREET, CLEVELAND 10, OHIO

the whole coupling rotates, transmitting the torque.

This coupling obtains its flexibility through design as compared with the conventional method of obtaining flexibility through the flexing of a resilient material. The purpose of the American Coupling is to permit shafts to operate misaligned without transmitting reactionary stresses which may increase the bearing temperature and accelerate the rate of bearing wear in the prime mover or driven machine.

USE SUBMERGED WELDING IN STEEL CAR MAKING

▲ Freight car production has been further accelerated by the installation of an assembly line based on radically new methods of manufacture for the construction of all-welded steel cars at the Chicago plant of the American Car and Foundry Company. Revolutionizing the production of cars, this ACF-engineered improvement takes advantage of the most advanced automatic submerged welding techniques. To these are added the use of pneumatic clamps and adjustable frames to hold a complete car roof or side to prevent slipping during welding. Where hand welding is necessary, the entire assembly can be rotated to enable welders to work downhand, which is accepted as producing the best results. The entire assembly line can be adjusted for whatever type or size car is to be produced.

A by-product of this new technique is the assurance of greater employee safety.

The first cars to be produced by means of this new method are 50 high speed express refrigerator cars for Atlantic Coast Line and 500 similar cars for Railway Express Agency. Despite the elaborateness of these cars presently under construction, ACF is meeting the contemplated production of 12 cars every working day.

Installation of these new facilities will be carried out in other ACF plants as rapidly as possible although materials required for this new equipment are still hard to procure.

The automatic welding process leaves the atmosphere clear of sparks and noise.

★ ★

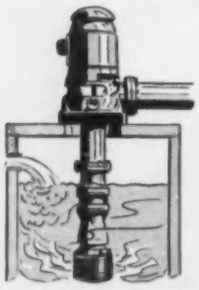
For Your Next Job — STOP and CONSIDER

the FLEXIBILITY of the

Peerless Vertical Turbine Pump

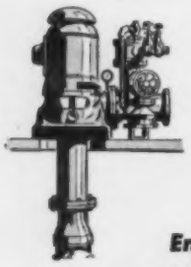
1. AS A DEEP WELL PUMP

For a dependable source of clean water, Peerless Vertical Turbine Pumps are recognized leaders in the field; noted for their adaptability to widest pumping conditions, they embody many exclusive engineering features for extended pumping efficiencies. Install these deep well vertical turbine pumps with the type of drive or combination most suitable to your specific application. Capacities from 15 to 30,000 g.p.m. are obtained from all practicable depths.



2. AS A CLOSE-COUPLED PUMP

You're assured of full turbine pump utility and capacities with an extremely compact installation. Ideal for pumping from short or medium settings. Capacities up to 30,000 g.p.m. are delivered from sumps, pits and surface water sources for booster service, circulating, de-watering and a host of other applications.



3. AS AN APPROVED FIRE PUMP

Install this versatile Peerless Vertical Turbine type Fire Pump, with proper fittings, for a permanent and reliable water supply for adequate plant fire protection. *Underwriters' approved*, these pumps produce from 500 to 2000 g.p.m. against heads to 285 ft. Extremely simplified in piping arrangement.

Engineering Information Available on All Three Vertical Turbine Types

Write to nearest office stating what your pumping conditions are; give diameter and depth of well, distance to water, capacity desired, total head, type of lubrication (oil or water) and type of drive. The bulletin that specifically describes the pump to fit your specific needs, together with appropriate engineering data will be furnished. Plan with Peerless Vertical Turbine Pumps!

PEERLESS PUMP DIVISION

Food Machinery Corporation

Factories: Los Angeles 31, Calif.; Quincy, Ill.; Indianapolis, Ind.
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PEERLESS PUMPS

WILSON RADIANT CONVECTOR FURNACES

ENGINEERED AND CONSTRUCTED BY THE

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20005 West Lake Road CLEVELAND, OHIO

Telephone ACademy 4670

These two-stack Wilson convector furnaces at the Dominion Foundries & Steel Limited of Hamilton, Ont., Canada, are producing 3.5 tons per furnace hour when annealing tin plate coils 54" O.D. piled 4 high.

INDUSTRIAL FURNACES ★ RADIANT TUBE HEATING ★ HEAT TREATING PROCESSES

A-C CRANE CONTROL HAS D-C SMOOTHNESS

▲ Recently the new "Magnetorque" control for overhead cranes was introduced. The Harnischfeger Corporation unit consists of a simple rotor and a stationary field member through which braking forces are exerted electromagnetically. It makes possible with a-c a smoothness of control and speed, of regulation to a degree which heretofore could only be achieved with d-c.

Many tests were performed, showing the safety, smoothness and accuracy of the new a-c crane control. Of particular interest was one test which consisted of letting loads of various capacities from one to seven tons descend upon a pushbutton with control steps at one-eighth inch intervals, each contact operating an electric light bulb. As the load was lowered, it actuated the pushbutton, step by step, causing the bulbs to light up one at a time, proving a convincing demonstration of the Magnetorque's smoothness and accuracy.

Many tests were conducted indicating the safety, smoothness and accuracy of the new a-c crane control.

YOU GET BETTER STEEL by this BETTER *Modern Method*

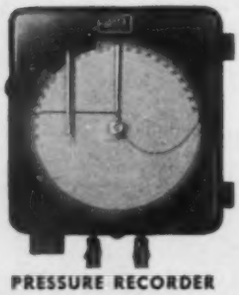
FURNACE PRESSURE CONTROLLER

Equipped with external manual adjustment for automatically operating stack damper to hold pressure constant.

These Hays Instruments may be used in Combination or Individually.

PRESSURE INDICATOR

An easy-to-read measurement of furnace pressure. Usually connected at the furnace roof.



PRESSURE RECORDER

A 24-hour record of furnace pressure. Shows timing of reversals and each change of pressure made by the operator during the heat.

IN up-to-the-minute open hearth plants you will find an increasing reliance on Hays Pressure Control.

Automatically this simple system regulates furnace conditions --relieves operators of many time-consuming details, gives them more time for more important duties. And Hays instrumentation can be complete or partial.

Here for a fact is "smart business." Better get the facts—write for them, or have a Hays engineer tell you about this better modern method. Representation in all principal cities of the United States and Canada.

The HAYS CORPORATION
COMBUSTION INSTRUMENTS AND CONTROL
MICHIGAN CITY, INDIANA, U.S.A.

ACHIEVE SEVEN RECORDS IN PITTSBURGH DISTRICT

▲ Seven all-time steel production records were achieved in action-packed 1947 at three Pittsburgh district plants of U. S. Steel.

Heeding the cry for more steel for peacetime goods, workmen at Homestead and Irvin works of Carnegie-Illinois Steel Corporation and at National works of National Tube Company, McKeesport, wound up the old year with record-breaking performances that exceeded even the best war years.

The National Tube plant set two all-time monthly records in December, not normally a top-notch month in steel production due to the holidays.

The corporation's adding machines today came up with these new marks:

Homestead works — 3,968,390 tons of steel ingots, old record 3,966,240 tons in 1944; No. 5 open hearth shop — 1,604,747 tons, old record 1,421,465 tons in 1945; 45-in. slabbing mill — 1,692,267 tons of slabs, old record 1,296,391 tons in 1945; 160-in. plate mill — 472,927 tons, old record 419,516 tons in 1945.

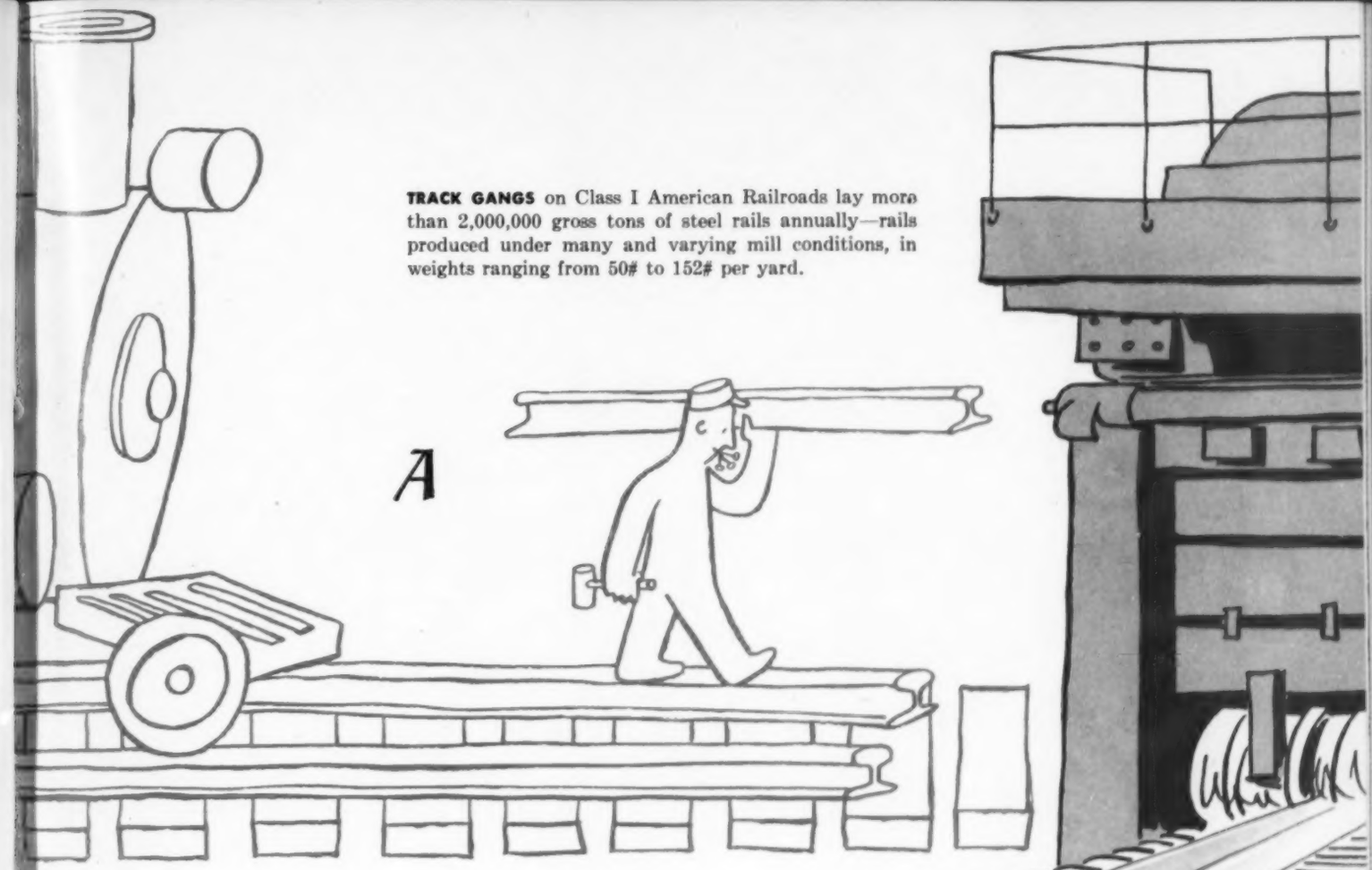
Irvin works — 80 in. continuous hot strip mill — 1,774,832 tons, old record 1,434,436 tons in 1944.

National works — open hearth shop — 892,703 tons of steel ingots, old record 892,116 tons in 1941; No. 1 seamless pipe mill — 253,750 tons of pipe, old record 228,103 tons in 1944.

The December monthly records at the McKeesport pipemaking subsidiary plant of U. S. Steel were: 109,269

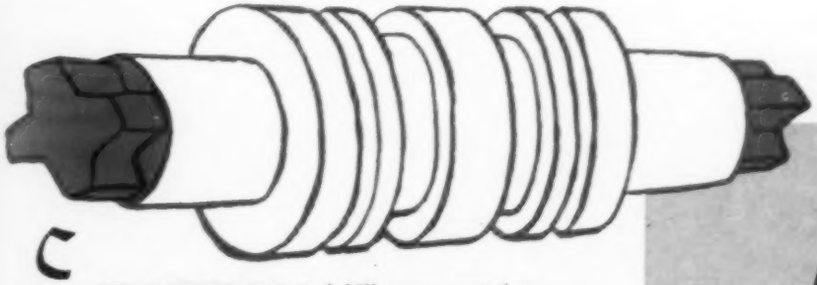
(*Please turn to page 121*)

TRACK GANGS on Class I American Railroads lay more than 2,000,000 gross tons of steel rails annually—rails produced under many and varying mill conditions, in weights ranging from 50# to 152# per yard.

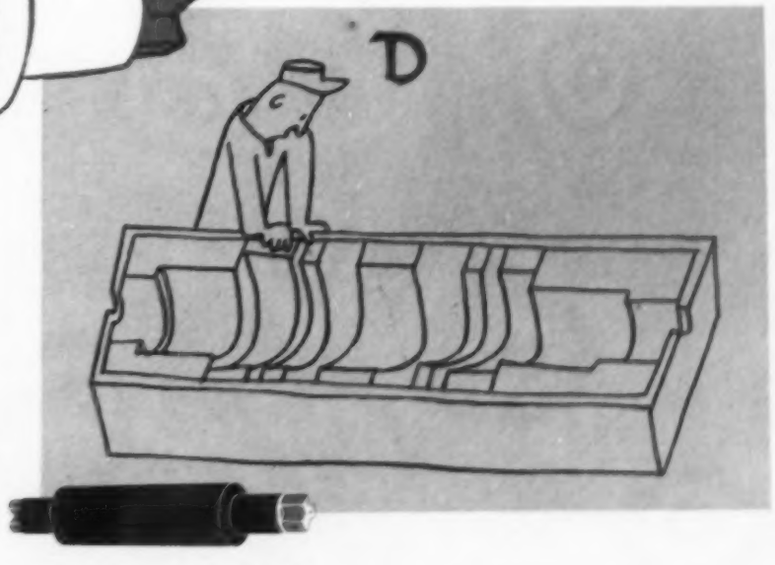


SKILLED OPERATORS direct the rolling function—control the rolling conditions for each operation, maintain the standards of finish and uniformity which assure customer acceptance and profitable production.

MACK-HEMP CRAFTSMEN and mill-wise M-H engineers combine their skills to supplement your know-how in the design, metallurgy and manufacture of Red Wabbler Rolls—the proper rolls for your production rolling operations.



RED WABBLER ROLLS fulfill your exacting requirements because your own rolling-mill experience guides Mack-Hemp engineers in the progressive development of rolls which establish the production records and set the standards of excellence for uniformity and finish.



MACKINTOSH-HEMPHILL CO.

Makers of the rolls with the red wabblers

PITTSBURGH AND MIDLAND, PA.

...for CLOSE SPOTTING and CONTROLLED DECELERATION... *Hydraulic Brakes* ARE BEST!

—only Wagner Hydraulic Crane-Bridge Brakes give you these features:

- **Two Types—Four Sizes—Cover the Field**

  Wagner hydraulic brakes for overhead traveling cranes and other industrial equipment are built with or without parking attachment, in four sizes that are capable of handling all bridge brake applications—light industrial cranes, high speed steel mill cranes, even the largest steel mill ladle cranes.

- **Remote Control Bleeder**

  Makes bleeding the hydraulic system a "one-man one-minute" job. Keeps lines full of fluid, maintains peak braking efficiency . . . solves problem of ladle crane applications.

- **Self-Centering Device**

  Assures equal clearance of *both* brake shoes, prevents either shoe from dragging. Other advantages include: power failure braking . . . one-point shoe adjustment . . . 200% emergency torque . . . grease fittings for lubrication . . . non-scoring molded lining blocks which can be easily replaced when worn.

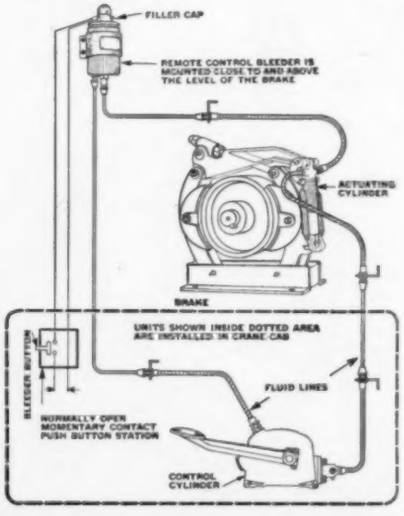
- **Modern Systems Easily Installed**

  If your cranes are not equipped with Wagner hydraulic brakes, let one of our field engineers show you how simple it is to install the modern system you need. All Wagner systems now include the remote control bleeder.

- **Old Systems Quickly Modernized**

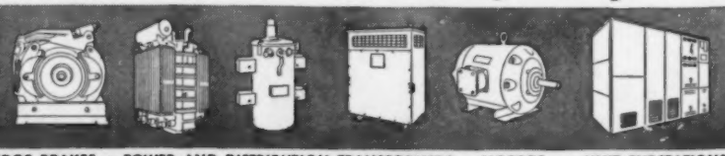
  You can bring your present Wagner system up-to-date with our complete-to-the-last-fitting conversion kits. You can change your old solenoid-controlled HM brake to the new, compact hydraulic-released type; you can convert a type H brake to an HM; and you can easily add the remote control bleeder to any Wagner system. Write for Bulletin IU-40 on Wagner Industrial Brakes.

Wagner Electric Corporation
6483 PLYMOUTH AVE., ST. LOUIS 14, MO., U. S. A.


FILLER CAP
REMOTE CONTROL BLEEDER IS MOUNTED CLOSE TO AND ABOVE THE LEVEL OF THE BRAKE
ACTUATING CYLINDER
BRAKE
UNITS SHOWN INSIDE DOTTED AREA ARE INSTALLED IN CRANE CAB
BLEEDER BUTTON
FLUID LINES
NORMALLY OPEN MOMENTARY CONTACT PUSH BUTTON STATION
CONTROL CYLINDER

Wagner Electric Corporation EST. WE 1891

Consult Wagner Engineers on all Crane-Bridge Braking Problems



BRIDGE BRAKES • POWER AND DISTRIBUTION TRANSFORMERS • MOTORS • UNIT SUBSTATIONS

ELECTRICAL AND AUTOMOTIVE PRODUCTS

148-2

(*Continued from page 118*)

tons of open hearth and bessemer steel ingots, old record 104,967 tons last October; blooming mill 86,395 tons of steel blooms, old record 84,305 tons in October 1946.

CENTRALIZED LUBRICATION ON ORE BRIDGES

▲ The advantages of centralized lubricating systems are never more apparent than in the lubrication of materials handling equipment such as ore unloaders and ore bridges. These vital pieces of equipment are difficult to lubricate properly because of their constant exposure to the elements and because of their size and construction.

Hand lubrication on unloaders and bridges is tedious, time-wasting, and in many cases, extremely hazardous.

Lubricating systems have been installed on a number of unloaders and ore bridges with outstanding success. In most cases these systems are operated with simple hand pumps since the bearings require lubrication only once or twice a day.

In the case of a Hulett ore unloader, seven "Type L" hand pumps, located at convenient points about the frame, make the lubricating job safe, easy, quick and positive. One man can now lubricate the entire machine in the space of a few minutes. The Trabon Engineering Corporation system with its single indicator at the pump is particularly advantageous in machines of this type where feeder locations are not easily excessible. The progressive hydraulic feeder operation makes sure that each bearing gets its full shot of lubrication.

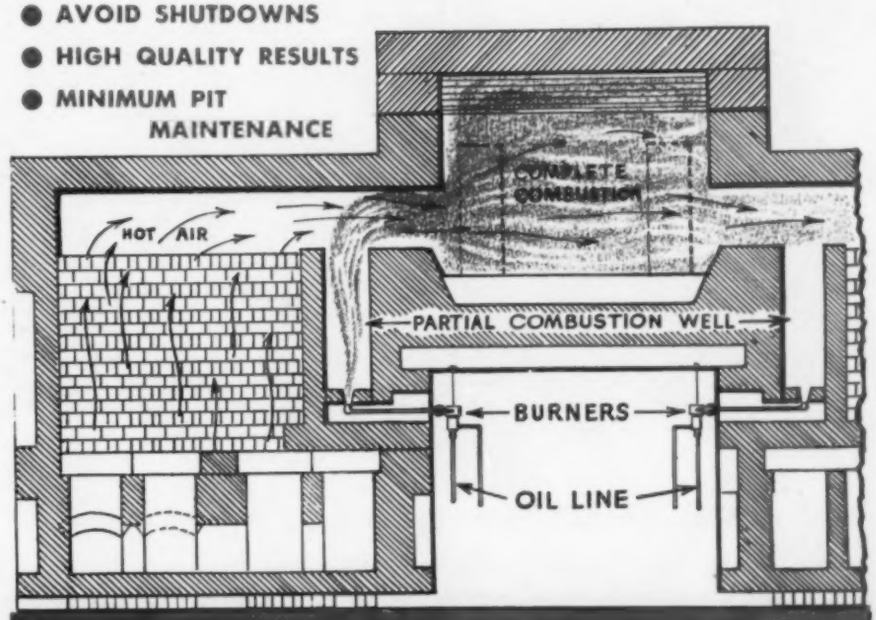
The seven pumps are located as follows: One pump is located on the rear sill to lubricate the idler wheels and drive shafts. The second pump is located in the bridge house and lubricates the bridge line shaft, drive mechanism, drive shaft and idler wheels on the front sill. The third pump in the bucket leg lubricates all bearings including the chain rollers and shafts for opening and closing the bucket jaws. Pump number four is located in the trolley house and lubricates the leg braces, trolley drives, walking beam, pivot pins and sheaves. Pump number five takes care of the bearings on the hopper. Pump number six is located in the larry car and lubricates all its bearings. The last pump is located in the "Dizzy House" on the walking beam and lubricates all the bearings in the house, all the sheaves on the walking beam, the pivot pins on the leg and the rotating ring.

In the case of ore bridges Trabon systems are used to lubricate the trolley, the legs and the rail clamps. Here again the tremendous distances involved and the exposure to the elements emphasizes the importance and utility of the centralized lubricating system. In addition to the outdoor equipment, Trabon systems are widely used on overhead cranes, locomotive cranes, manipulating and handling equipment, and millwright equipment itself.

Centralized lubrication is used on ore bridges to lubricate the trolley, the legs, and the rail clamps.

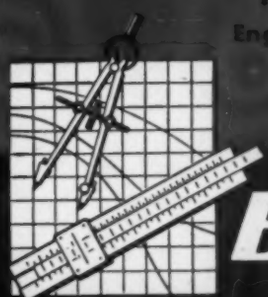
Burn Oil IN REGENERATIVE SOAKING PITS by BLOOM method

- AVOID SHUTDOWNS
- HIGH QUALITY RESULTS
- MINIMUM PIT MAINTENANCE



The Bloom method for oil firing of regenerative soaking pits gives quality heating that compares favorably with gas operation. The installation is such that gas or oil can be used interchangeably.

This is another example of how Bloom Engineered applications can serve industry.



BLOOM ENGINEERING CO.

857 W. North Avenue Pittsburgh 12, Pa.

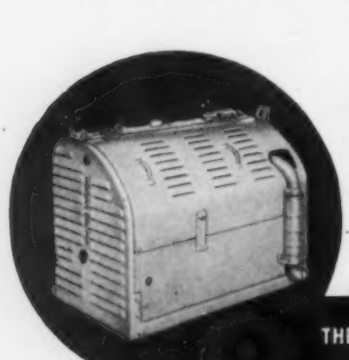
more power

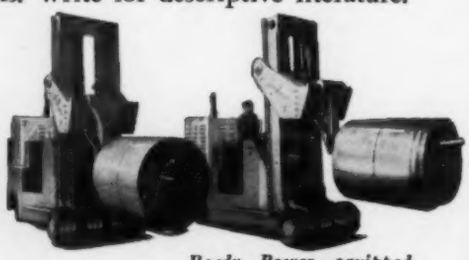
WITH READY-POWER

Ready - Power - equipped Elwell Parker Up Ender handling heavy steel coils.

FOR ELECTRIC TRUCK OPERATION AT ITS BEST!

Ready-Power-equipped electric trucks provide more power for heavy loads, more continuous hours of service and more materials handled in any given period. Dependable electric power is generated right on the truck chassis by an engine-driven, direct-current generator. Get the most out of your electric trucks. Convert them to Ready-Power. Specify Ready-Power on your new trucks. Write for descriptive literature.





Ready - Power - equipped Automatic Ram Trucks handling steel coils.

THE READY-POWER CO.

3836 Grand River Ave., Detroit 8, Michigan

On all this equipment bearing life is greatly increased and bearing repair bills and down-time because of bearing breakdowns is greatly reduced.

KAISER'S FONTANA MILL BREAKS RECORDS IN 1947

▲ The Fontana steel plant of Kaiser Company, Inc. announces that every department in the mill broke its record in 1947. The plate mill record was the postwar record. The figures are as follows:

	RECORD		PREVIOUS RECORD	
	N. T.	Date	N. T.	Date
Furnace coke	332,244	1947	329,830	1944
Hot metal	459,715	1947	354,098	1944
Sinter	355,575	1947	315,388	1944
Ingots (O.H.)	795,728	1947	624,164	1946
Soaking pits	741,056	1947	615,973	1946
36 in. mill	594,053	1947	395,602	1946
Finished plate —				
Postwar	188,202	1947	126,927	1946
All time	340,344	1944	.....	....
29 in. mill billets and shapes	289,346	1947	248,253	1946
Merchant mill (Incl. skelp)	171,372	1947	134,761	1946

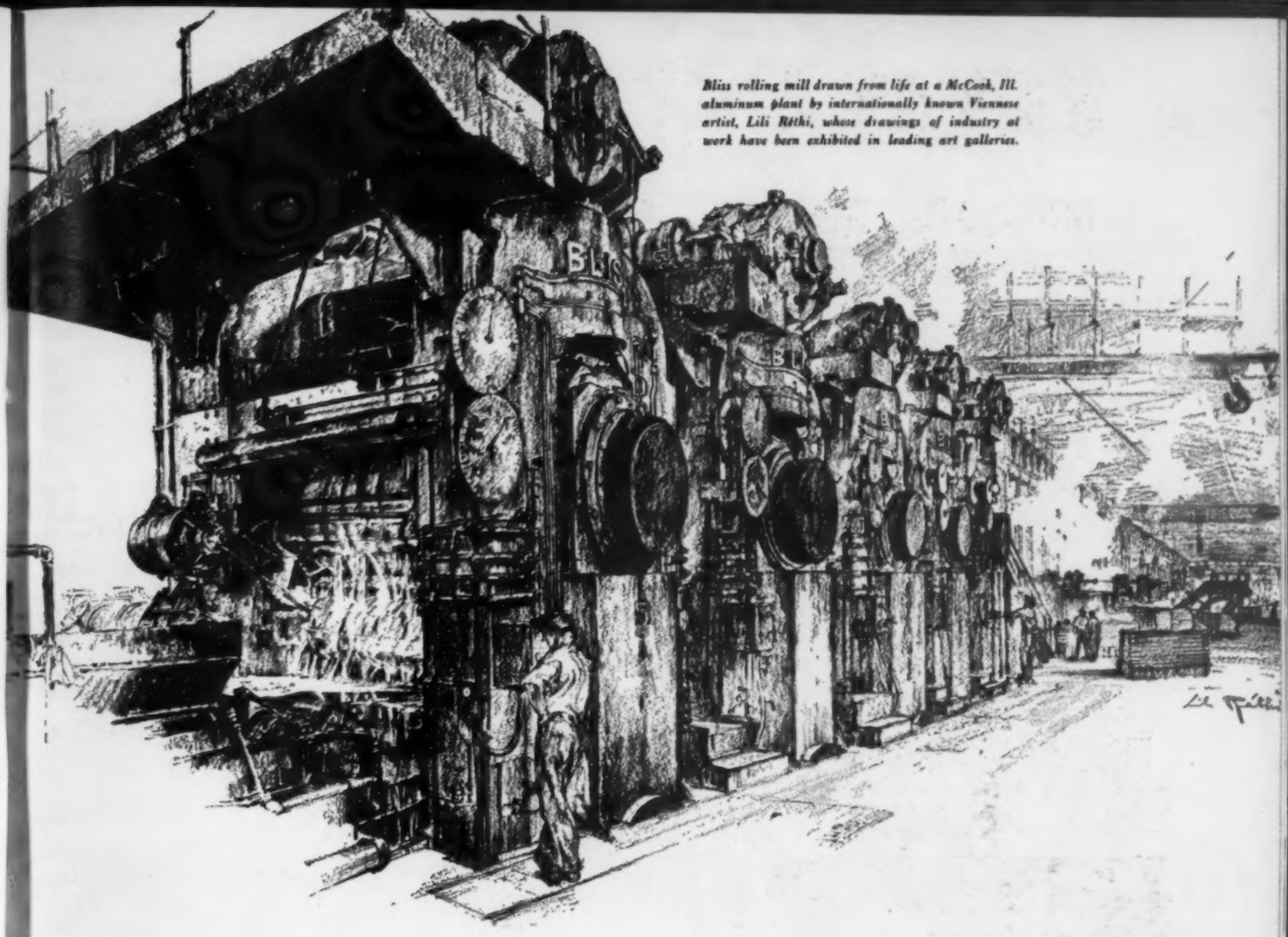
All departments broke their monthly records at least once during the year 1947. The following shows a tabulation of the number of times:

Department	Number of Times Record Broken in 1947
Vulcan ore	2
Sunnyside coal	1
Blast furnace coke	1
Sinter	2
Hot metal	1
Ingots	7
Soaking pits	5
Plate — postwar record	5
36 in. mill products	6
29 in. mill products	3
Merchant mill	5
Mill products produced for sale	5
Steel products shipped	3
Mill products shipped	4

REPUBLIC STEEL HAS RECORD PRODUCTION

▲ Production records running as high as 29 per cent over previous all-time highs were set by Republic Steel Corporation facilities in 1947, E. M. Richards, vice president in charge of operations reported recently.

As a result, finished steel shipments



Bliss rolling mill drawn from life at a McCook, Ill. aluminum plant by internationally known Viennese artist, Lili Réthi, whose drawings of industry at work have been exhibited in leading art galleries.

The Third Dimension of Invention

The great creative strength of American industry is due, in no small measure, to its ability to place behind every inventor and his idea, men of equal genius, who provide *the means of production.* Without this means, this Third Dimension of Invention, our genius for creation would be unfulfilled.

The E. W. Bliss Company exemplifies this tradition of partnership between invention and means of production. For 90 years it has provided equipment for furthering mass-production of pressed metal articles...today, equipment from the four-high, five-stand tandem hot-strip aluminum rolling mill illustrated above, to presses of every type and size for fabricating all metals into finished products at low cost.

Think of the engineering and production knowledge vested in a company that has operated as a leader throughout an almost-century of the greatest industrial development the world has ever seen. You can put it to work for you. You will find answers to many problems which lie ahead.

E. W. BLISS COMPANY, DETROIT 2, MICHIGAN

PRESSES **BLISS** THE THIRD DIMENSION OF INVENTION *ROLLING MILLS • CAN MACHINERY*

from Republic mills soared to a new all-time high of 6,074,000 tons — nearly 140,000 tons over 1941, the previous high year.

Production of wire products led the list of new records, up 29 per cent over the 1945 previous high. Nails, badly needed in the national housing program, were produced at a rate of 23 per cent greater than ever before.

Another impressive production gain was set by the cold rolling mills. Republic produced 27 per cent more cold rolled sheet and strip than the 1946 record year. Demand for cold rolled steel is at an unprecedented high.

Pipe, for which there has also been a tremendous demand, was produced at a rate of 22½ per cent greater than any previous year.

Other production records included: hot rolled strip up 14 per cent; drawn wire up 10 per cent; bars, rods and skelp up 5 per cent (bars alone up 10½ per cent).

In addition total coke production was up 6 per cent over the best previous year. Production of sintered iron ore also went to a new high, 14 per cent above the record 1943 year.

WHEELING STEEL BUYS COAL BARGES

▲ Wheeling Steel Corporation has ordered 13 coal hopper barges from Dravo Corporation. Each will be 210 ft long, 26 ft wide and 10 ft-8 in. deep. Since the end of the war, Wheeling has ordered 28 barges of this type from Dravo.

KOPPERS ACQUIRES GRANITE CITY PLANT

▲ Koppers Company, Inc., will acquire all outstanding stock of Missouri-Illinois Furnaces, Inc., an Illinois corporation formed last October 1 to purchase the government-owned blast furnace and coke plant at Granite City, Illinois, it was announced recently.

At the same time, M. T. Herreid, Koppers' vice president and president of Missouri-Illinois, announced that the War Assets Administrator and the Department of Justice have approved the sale of the local plant to Missouri-Illinois (with Koppers as owner of all its stock) for $3,255,000.

Since Koppers has operated the plant at government request for nearly seven years, Hanna Coal and Ore Corporation has agreed to sell its stock in Missouri-Illinois to Koppers. Koppers will purchase Hanna's stock in the corporation, and the corporation will reimburse Hanna for working capital placed in the business. Koppers has agreed to assume all obligations to pay the balance due the government over a period of 10 years.

McDONALD MILL SETS RECORDS IN 1947

▲ One mill alone produced more than 1000 extra car loads of steel as U. S. Steel rolling units chalked up two all-time steelmaking records in 1947 at McDonald, Ohio, works of Carnegie-Illinois Steel Corporation.

The plant's 43-in. continuous strip mill went far ahead of the best previous annual record by turning out 732,445 tons of steel coils. The old

In all your
PICKLING OPERATIONS

LET THE NEW
WELDCO
MECHANICAL PICKLER

Are you pickling bars, tubing, rounds, flats, squares, or hexagons? Then it will pay you to check these 7 big advantages of the new WELDCO Pickler:

1. Saves 40 to 60% pickling time.
2. Saves on man power, steam, and maintenance work.
3. Uses a minimum amount of chain—often an expensive replacement item.
4. Mechanical operation provides a more vigorous pickling action, exposing all surfaces to the solution and speeding scale removal.
5. Can be built to any capacity.
6. Can be made to fit any type plant.
7. Simplicity in operation and control—no complicated mechanism.

Call or write for complete information on the new, easy-to-use Mechanical Pickler. Our trained engineers will be glad to advise you on such matters as pickling plant layout and design, pickle liquors, temperature control, ventilation, and selection of tanks.

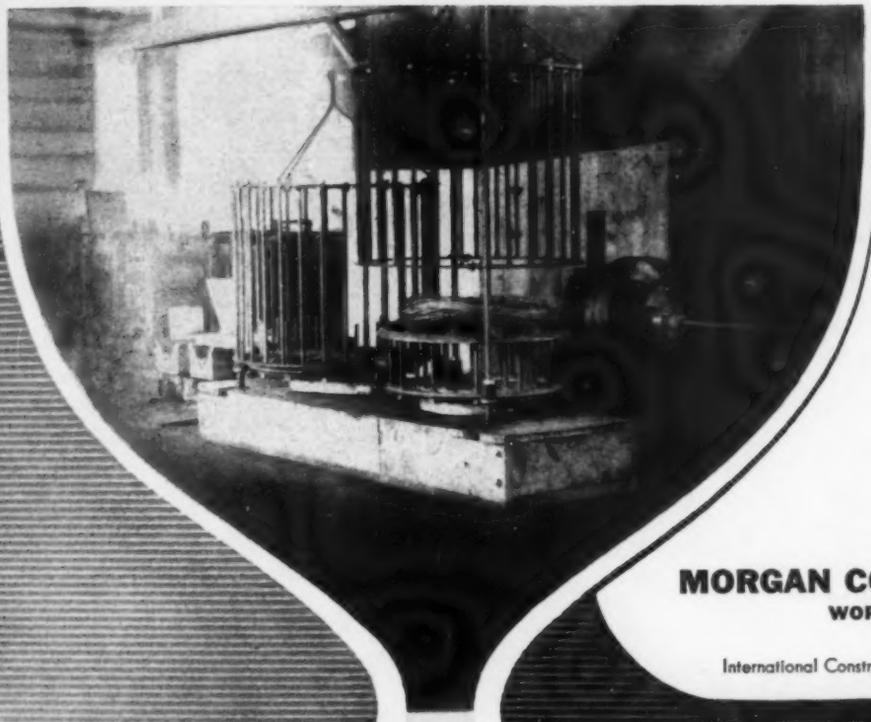
Other WELDCO Pickling Products include Pickling Crates, Baskets, Chains, Hairpin Hooks, Jets, and Scrubbers. Catalogs available on request.

THE YOUNGSTOWN WELDING & ENGINEERING CO.
3700 OAKWOOD AVENUE . . . . YOUNGSTOWN 9, OHIO

Time takes no holiday

Rolling mill methods are constantly changing—and *improving*. Each new mill is engineered to supersede the old in output, quality and efficiency.

BELOW . . . AN EARLY TYPE OF POURING REEL



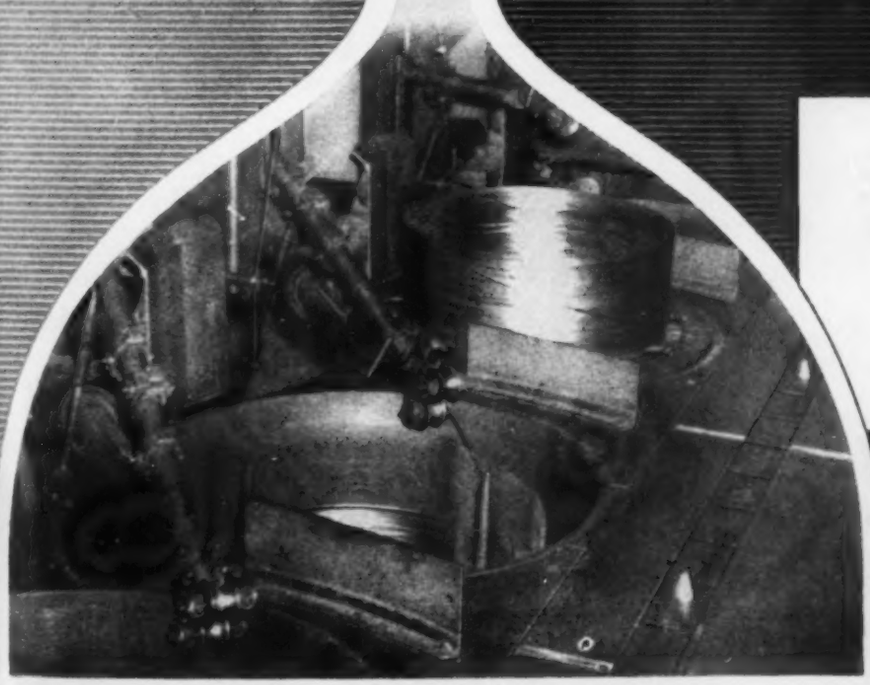
Since introducing the first successful continuous rod mill in 1888, Morgan designers have constantly added to the technology. Visualize this from the old and new pouring reels shown at left.

Close and frequent contacts with rolling mill designers is the *only* way to keep abreast of these developments.

Why not have one of our men visit you soon? . . . or better, plan a visit to Worcester and talk it over.

MORGAN CONSTRUCTION COMPANY
WORCESTER, MASSACHUSETTS

English Representative:
International Construction Co., 56 Kingsway, London, W. C. 2, England



ABOVE . . . MORGAN'S MODERN POURING REEL

MORGAN
WORCESTER

Rolling Mills - Wire Mills - Gas Producer Machines - Regenerative Furnace Control

RM-1F

record of 688,249 tons was marked up in the busiest war year, 1944.

Another record-breaker was the 12-in. strip mill, with 104,190 tons of narrow strip steel. This topped the former high of 102,581, also established in 1944 when all of the nation's steel mills were busy rushing out war goods.

HAND POWER CUTTERS HAVE 15 IMPROVEMENTS

▲ In announcing a new redesigned improved complete line of hand power cutters featuring 15 improvements, H. K. Porter, Inc. stresses a new degree of ease, strength, safety and performance in the cutting of bolts, rods, wire, cable, chain, bars and metal of all kinds. Of the 15 improvements these are cited as being of particular benefit to users: curved toe-in handles which decrease armspread and wrist bend making an easier and stronger pull, broad rounded palmfit grip which reduces fatigue, no protruding screws or bolts to catch, metal safety handle stop, 30 per cent greater tool strength in sections and handles, jaws plainly marked showing capacity and type of metal safety cut, and red color finish. All standard models have all new features.

SHEET AND TUBE MAKES NEW SAFETY RECORD

▲ The Youngstown district metallurgical department of Youngstown Sheet and Tube Company set a new record by operating more than 2,000,000 man-hours without a lost time accident. It is an all-time safety record for any department in the company.

The record is all the more important because members of this department are exposed to nearly all steel plant hazards. Metallurgists work in nearly all departments of the plant and in addition do considerable traveling and visit other plants to study customer problems. The period began in September, 1938, and covers all of World War II when many girls were employed in the department.

VIBRATING UNIT SPEEDS FROZEN COAL UNLOADING

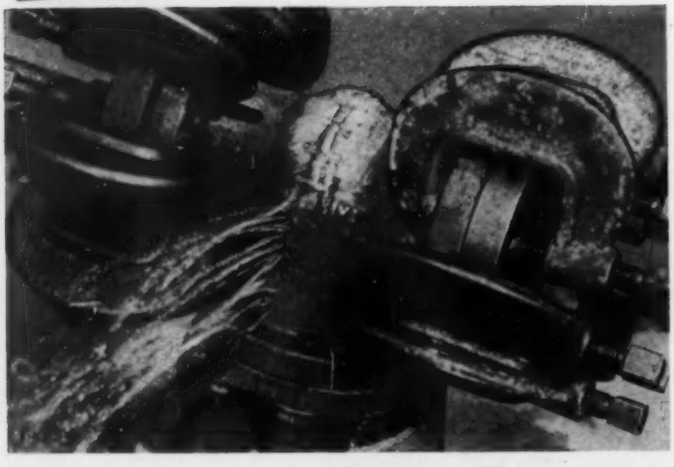
▲ An electric-powered vibrating unit that unloads frozen coal from hopper-type railroad cars in an average of less than 10 minutes and speeds the turn-around time for these critically short cars, was given its first public demonstration at the Inland Steel Company's Indiana Harbor works here recently.

The new device, the Robins car shakeout, replaces the manual method used by many industries, which requires up to 20 men with sledge hammers, pickaxes, poke bars, and shovels to empty a single frozen car.

"The shakeout materially speeds up the time of unloading cars as compared with previous methods used," F. M. Gillies, works manager at Inland's Indiana Harbor works, said: "In addition to decreasing the damage to the railroad equipment, it diminishes labor requirements in a

(*Please turn to page 152*)

METALOCK
Registered Trademark
A MECHANICAL REPAIR FOR WRECKED MACHINERY
THOUSANDS SAVED BY *On location* REPAIRS WITH METALOCK



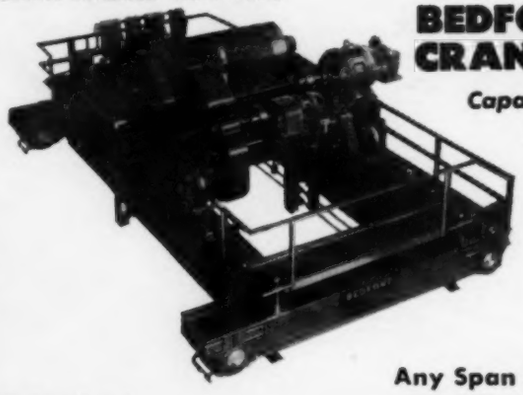
2200 psi held by METALOCK Repair.

In official Navy test a 3 in. valve, tested to destruction, ruptured outside the repaired area leaving repair intact.

METALOCK REPAIR SERVICE
General Office: Pennsylvania Division, 530 WILLIAM PENN PLACE
PITTSBURGH 19, PA.
HOME OFFICE: LONG ISLAND CITY 4, NEW YORK

CRANE BUILDERS Since 1903

BEDFORD CRANES
Capacities 5 to 150 Tons



Designed and Engineered to Meet Your Requirements

Any Span or Lift
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ELECTRIC OVERHEAD TRAVELING CRANES
GANTRY CRANES • STEEL DERRICKS
BUILT TO YOUR SPECIFICATIONS
STRUCTURAL STEEL • STEEL BUILDINGS

BEDFORD FOUNDRY & MACHINE CO.
Engineers
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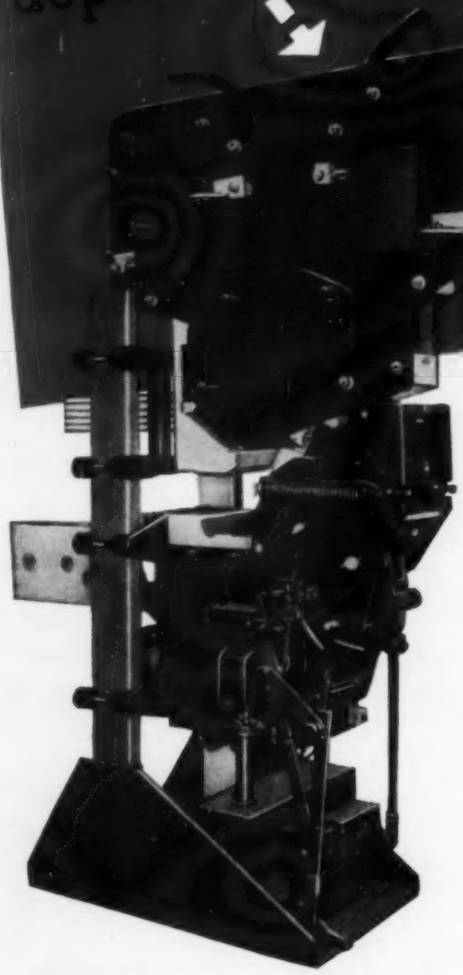


Type MT single pole, electrically operated, Automatic Reclosing Circuit Breaker. 250 and 750 Volts — D-C.

Interrupting Capacity is 150,000 Amp. in ratings 2000 and 4000 Amp.; and 250,000 Amp. in ratings 6000 and 12,000 Amp.

ELECTRICAL disturbances in your power distribution system hit you where it hurts most—right in the heart of your production.

Protect your essential production equipment from the hazards of electrical disturbances with the I-T-E MT (Mill Type) Automatic Reclosing Circuit Breaker. The MT is a unit of dependable, full-time protection; engineered and built by I-T-E—*specialists* in *quality* Switchgear.

Especially designed for quick interruption of extremely heavy direct-currents, the MT breaks a circuit in about 1¾ cycles (60 cycle basis) at 25% to 100% of interrupting capacity. Minor disturbances are cleared—through quick opening and automatic reclosing—with virtually no interruption of service.

It is electrically and mechanically trip-free on overcurrent, and trips immediately when closed on a fault. All tripping devices are direct-acting and instantaneous. The main contacts are solid copper blocks with silver alloy inserts for protection from oxidation and overheating. Secondary contacts guard the main contacts from arcing damage. Arcs are quickly and safely extinguished by the I-T-E designed magnetic blow-out coil and arc chute.

Normally built in two styles—for either panel mounting or pedestal mounting, the MT has a sturdy frame of hot-rolled steel, formed and welded into a rugged, protective support unit. Pantograph drawout and truck mountings can also be furnished if desired.

For complete details on the I-T-E Type MT Automatic Reclosing Circuit Breaker, send for illustrated catalog 2201. *Ask the I-T-E representative in your locality for information on applying the MT—and other I-T-E protective equipment—to your electrical distribution system. His services are available with no obligation.*

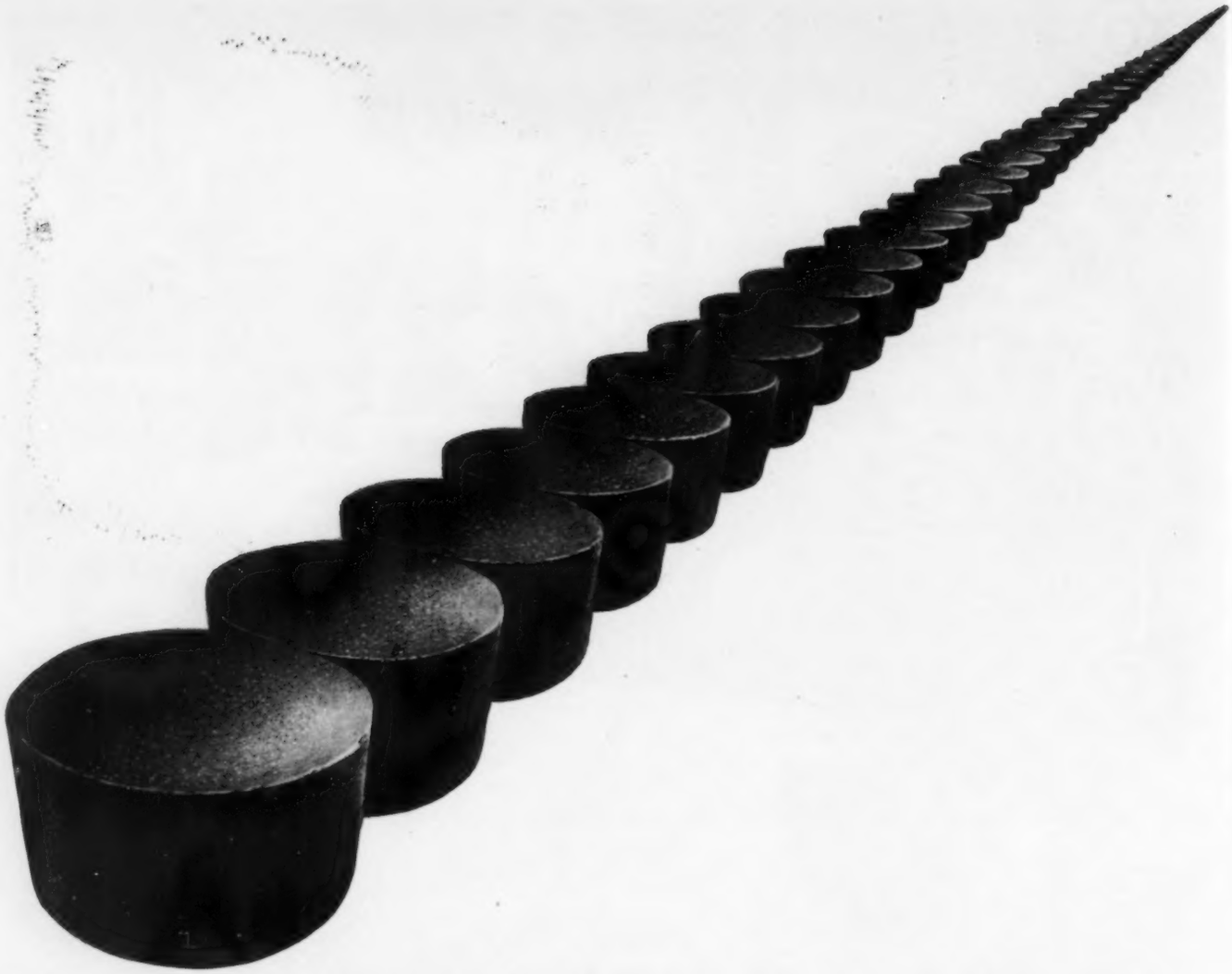
I-T-E

MILL TYPE SWITCHGEAR

The Leader In Technical Excellence

I-T-E CIRCUIT BREAKER CO., 19TH & HAMILTON STS., PHILADELPHIA 30, PA.—31 OFFICES IN UNITED STATES AND CANADA

SWITCHGEAR • UNIT SUBSTATIONS • ISOLATED PHASE BUS STRUCTURES • AUTOMATIC RECLOSING CIRCUIT BREAKERS • HIGH SPEED CIRCUIT BREAKERS



Timken used 45,000 Carbon Mold Plugs

_THEN SAID:

*"Carbon plugs are never out-of-round and are consistently accurate in dimensions. They are structurally strong and may be handled without damage . . . can be hammered into place in the mold opening without being crushed. A large percentage may be employed a second or third time.

"Their use has eliminated 90 pct of the leakers . . . absence of leakers has reduced steel loss to a minimum and has prevented the burning of mold buggies and railroad ties and rails under the mold buggies. Reliance on the plugs has improved pouring conditions by eliminating stop-pours, skulls, sticking blackheads and other pouring difficulties.

"Carbon mold plugs do not spall. There can be no refractory absorbed into the ingot from the plug, which practically eliminates the possibility of inclusions from the mold plug. Little or no carbon pickup is noted in ingots of steels over 0.10 C.

"Elimination of burn-outs in the plug holes has improved mold life by 10 pct. There is no contamination of soaking pit bottoms if the carbon plugs adhere to the ingot bottom. As compared with any other plug of the same size, the carbon type is light and very easily stored or handled . . . a decided advantage has been gained in producing alloy steel of the best quality."

**From an article entitled, "Carbon Mold Plugs . . . In Alloy Steel Production" which appeared in the November 27, 1947, issue of* Iron Age.

NATIONAL CARBON COMPANY, INC.

Unit of Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, N. Y.

UCC

Division Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

For reprints of this article on carbon mold plugs, write to National Carbon Company, Inc., Dept. IS.

Personnel News . . . .

J. L. Mauthe, vice president in charge of operations, was elected a director of Youngstown Sheet and Tube Company to succeed Newell C. Bolton of Cleveland, Ohio, who died December 27. Mr. Mauthe, a native of Turkey City, Clarion County, Pennsylvania, is a graduate of Penn State. After graduation Mr. Mauthe went to Carnegie Steel Company's blast furnaces at Duquesne, Pennsylvania, as a laborer. In 1914 he joined National Tube Company at McKeesport, Pennsylvania, and four years later became superintendent of blast furnaces for Midvale Steel Company at Coatesville, Pennsylvania. The next year he joined Illinois Steel Company at Gary, Indiana, as assistant superintendent of blast furnaces. From there he went to National Tube Company at Lorain, Ohio, as assistant superintendent. He joined Youngstown Sheet and Tube Company in 1935 as assistant superintendent of the Campbell plant. Two years later he became general superintendent of the Youngstown district and in 1943 was elected vice president in charge of operations for the entire company.

J. H. Krehl, assistant to the Youngstown district manager of Youngstown Sheet and Tube Company, has retired after 46 years' service. Mr. Krehl joined the company February 26, 1902 as a machinist apprentice. Four years later he became a machinist, in a few years was appointed assistant shop foreman, then shop foreman and later foreman of all shops. In 1917 he was appointed master mechanic, became superintendent of maintenance a few years later, assistant to the general superintendent in the Youngstown district in 1937 and assistant to the Youngstown district manager in 1947.

Robert E. Lewis has been appointed assistant to the district manager of Youngstown Sheet and Tube Company. Mr. Lewis joined Brier Hill Steel Company in 1917 as assistant superintendent of the electrical department and three years later became superintendent. When Brier Hill was purchased by Youngstown Sheet and Tube Company in 1923, Mr. Lewis was made superintendent of the electrical department for the Youngstown district. In 1937 he was appointed superintendent of maintenance for the Youngstown district, a position he held until his recent promotion.

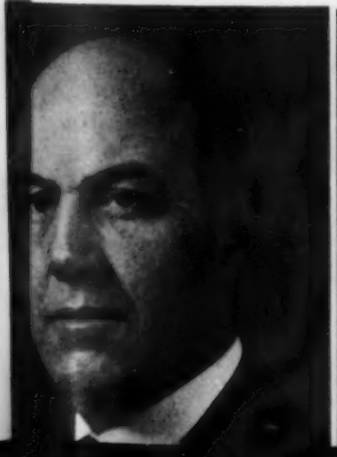
Dr. G. V. Slottman, formerly manager, technical sales division for Air Reduction Sales Company has been appointed technical assistant to the vice president. Dr. Slottman, who has been with Air Reduction for 12 years holds degrees from Massachusetts Institute of Technology and the University of Berlin. He is a former professor of chemical engineering at MIT and has been closely associated with Air Reduction's development and introduction of steelmaking processes using large quantity, low-purity oxygen for both combustion purposes and as a chemical reagent.

Scott D. Baumer, formerly assistant manager, technical sales division for Air Reduction Sales Company was appointed manager of that division. Mr. Baumer received his education at Princeton and the University of Pittsburgh. He then spent several years in grey iron and steel foundry production. After 14 years with Bethlehem Steel in both production and maintenance work, he joined Air Reduction in 1941.

E. H. Roper was appointed assistant manager of the technical sales division of Air Reduction Sales Company. Mr. Roper, a graduate of Sheffield Scientific School, Yale University, joined Air Reduction in 1936. After having served in the applied engineering department and the metropolitan sales district, he was made assistant to the manager, technical sales division in 1946, a position he held until his recent promotion. Mr. Roper is a licensed professional engineer.

John R. Gaut was appointed assistant manager of Chicago district operations of American Steel and Wire Company. A native of Greensburg, Pennsylvania, Mr. Gaut was awarded a bachelor of arts degree at Williams College before starting work for American Steel and Wire at the Donora, Pennsylvania, steel works in October, 1919. From his initial position as steel tracer, he moved rapidly upward through the ranks at Donora before being transferred in February, 1929, to Worcester, Massachusetts, where he was made assistant department foreman in the round wire department at North works. From January, 1940, to May, 1941 he performed special duties in the office of the vice president in charge of operations at Cleveland. He then was moved to Waukegan where he was made assistant

J. L. MAUTHE



J. H. KREHL

ROBERT E. LEWIS

DR. G. V. SLOTTMAN

LOOK TO THE FUSE LEADER FOR PRODUCTION PROGRESS

Double Fibre Bridge Assembly *Increases Strength 10 Times*

WARE HI-LAG Fuses have the strongest, most rigid knife blade assembly ever designed in fuses. The two heavy fibre bridges are supported by sturdy brass brackets which add greatly to the strength of the assembly. These bridge supporting brackets are attached to the copper knife blades and contact the entire end of links so that current flows through the brackets as well as the blades over a large area. Another reason for WARE HI-LAG Fuse's cool operation.

Perfect alignment is always maintained in this knife blade assembly with links centered in casing. The links are quickly and easily replaced or removed by loosening the nuts and slipping in or out.

WARE HI-LAG FERRULE FUSE CONSTRUCTION

Our ferrule type fuse has a heavy brass bar, which locks into open end ferrule, bridging fuse case. This bridge locks link to prevent twisting and cap tightens on new center contact. No sagging washers or twisted links to cause overheating.

Start using WARE HI-LAG Fuses today! Make them Standard Equipment for greatest economy and satisfaction. Investigate *now!*

APPROVED BY UNDERWRITERS' LABORATORIES

Write for Fuse Booklet No. 4460 giving all features, sizes and details.

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general superintendent. Mr. Gaut has been general superintendent of the Waukegan plant since March, 1943.

Nelson W. Dempsey was named general superintendent of the Waukegan, Illinois, works of American Steel and Wire Company. Mr. Dempsey was born in Stoneham, Massachusetts, and is a graduate of Tufts College where he earned his bachelor of science degree in chemical engineering. His first position with American Steel and Wire was as a laboratory technician at Worcester where he began in May, 1917. Following a 15 month interruption due to military service, he returned to the wire company in February, 1919, and subsequently held a number of positions in the Cleveland and Pittsburgh districts before being named assistant to superintendent of North works at Worcester. In February, 1944, Mr. Dempsey was transferred to Waukegan as assistant superintendent of the wire division, and seven months later he was named division superintendent, which position he has held to the present time.

Vernon L. Strohm has been moved up to division superintendent of wire mills at Waukegan works of the American Steel and Wire Company. Born in Desmet, South Dakota, Mr. Strohm has worked for the wire company since November, 1923, when he started as a tractor helper in the wire mill at Waukegan. His entire career has been in Waukegan where he has held a number of positions, the latest being department superintendent of the dry drawing department.

Daniel E. Wise was made chief engineer of both Clairton works and Isabella Furnaces of Carnegie-Illinois Steel Corporation. Mr. Wise succeeds **J. Wallace Allen,** who will continue at Clairton works in a consulting capacity. A native of Alliance, Ohio, Mr. Wise was graduated from the Case School of Applied Science and Yale University. He started with Carnegie-Illinois in 1937 as a steam engineer at Ohio works, Youngstown, Ohio, and the following October became assistant chief power and fuel engineer there. He was transferred to the company's general offices in Pittsburgh as a power and fuel engineer in 1941 and returned to Ohio works as chief project engineer two years later. Mr. Wise came to Clairton in April 1944 as assistant

DANIEL E. WISE

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The Controlled-Lift of Durabla Metal Pump Valve Units* utilizes exclusive design features which are a guarantee of maximum efficiency in pump valve design. Durabla Valves are designed to give just the proper amount of lift in order to insure a minimum amount of slip, cavitation, or turbulence and minimum use of power to operate the valves.

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chief engineer, and held that position until his new appointment.

Russell Eckles was promoted to assistant chief engineer at the Clairton works of Carnegie-Illinois Steel Corporation. Mr. Eckles is a native of New Bedford, Pennsylvania. He began with Carnegie-Illinois as a draftsman in 1917 at the company's New Castle, Pennsylvania plant. He came to Clairton works in 1936 as a draftsman and was named assistant to chief engineer last May.

John A. Schwer was appointed assistant to the general superintendent, Gary sheet and tin mill, Carnegie-Illinois Steel Corporation, Gary, Indiana. Mr. Schwer has been associated with the corporation since

JOHN A. SCHWER

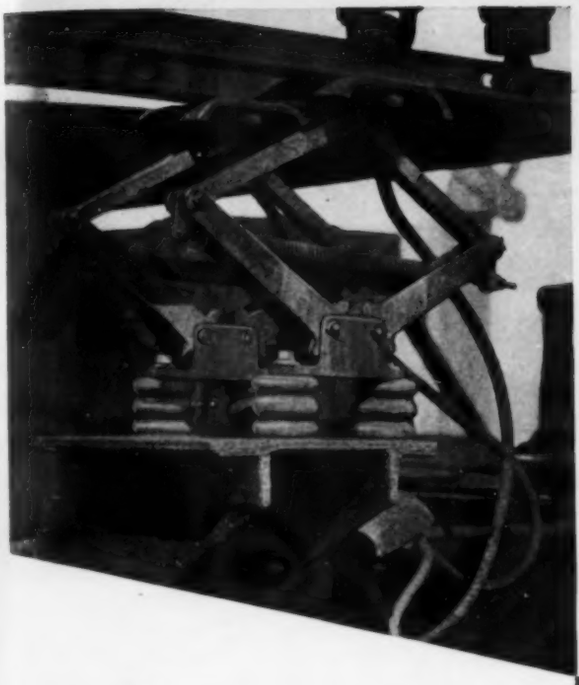
it was organized in 1901. He started with the American Steamship Company in Pittsburgh and then, in 1904, became associated with the former American Sheet and Tin Plate Company in the order department at Vandergrift, Pennsylvania. He has served as production planning superintendent at Gary sheet and tin mill since July 1, 1936.

Joseph M. Greer succeeds John A. Schwer as superintendent of production planning at Carnegie-Illinois Steel Corporation's Gary sheet and tin mill. He became associated with Carnegie-Illinois at Duquesne, Pennsylvania, works in 1937. He joins the Gary sheet and tin mill staff after serving as assistant to general manager of production planning of the Carnegie-Illinois Steel Corporation in Pittsburgh.

John J. Hart, Jr. has been named sales manager of the recently-formed industrial safety products division of Watson-Standard Company, Pittsburgh, Pennsylvania.

Mr. Hart goes to Watson-Standard from the Lake Erie Engineering Corporation where he was district sales representative and later assistant manager of the firm's Feller Engineering division. Headquarters of the new division are in the Clark Building.

Merle J. Graham was advanced to manager of the West Leechburg, Pennsylvania, plant of Allegheny Ludlum Steel Corporation. Mr. Graham, 38 and a native of Oakmont, Pennsylvania, joined the company in 1933 after being graduated from Lehigh University. After eight years in the service departments of the



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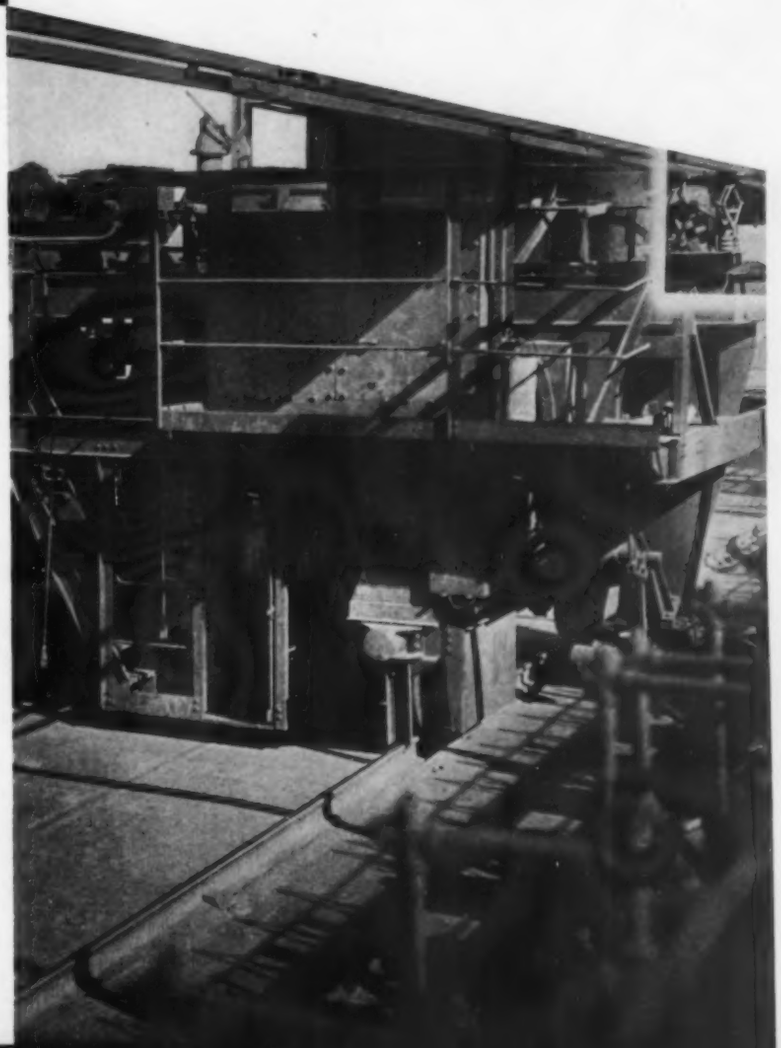

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Brackenridge and West Leechburg plants, he was named production manager of the defense plant operated by the company during the war at Dunkirk, New York. He went on military leave in 1943 for service in the Navy, and, upon discharge in 1946, was made assistant manager of the West Leechburg plant. He was named acting plant manager early in 1947.

Frank G. Benford was made assistant plant manager at the West Leechburg plant of Allegheny Ludlum Steel Corporation. Mr. Benford, 36, was graduated from Penn State as a metallurgical engineer in 1933 and for the next eleven years worked as a metallurgist for General Electric Company in Schenectady, New York. He joined Allegheny Ludlum as chief metallurgist of the West Leechburg plant in 1945.

J. Robert Pauline has been appointed works manager for the Kellogg division of the American Brake Shoe Company.

Mr. Pauline, formerly assistant to the vice-president in charge of operations and engineering, has served in various supervisory capacities since 1943 when he first joined the brake shoe firm as an engineer. Prior to 1943 he was connected with the Burnham Boiler Corporation in Irvington, New York.

In his new position he will continue to be located at the division headquarters in Rochester, New York.

Charles Pomeroy Collins was elected president and a director of Norma-Hoffmann Bearings Corporation. Mr. Collins will resign his present duties as secretary and general counsel of SKF Industries, Philadelphia, Pennsylvania. Mr. Collins attended the University School, Cleveland, Ohio, Mercersburg Academy, Mercersburg, Pennsylvania, Princeton University, Columbia University Law School, and received his law degree from New York University Law School in 1928.

Since 1942 Mr. Collins has been associated with SKF Industries, Inc., Philadelphia, Pennsylvania, and from 1943 to the present time has been secretary and general counsel, a member of the general staff participating in all policy decisions, and general advisor to all departments of the company.

Giles R. Locke was appointed assistant to the vice president in charge of operations, Republic Steel Corporation. Mr. Locke will assume the duties formerly undertaken by the late William M. Neckerman, in connection with development and production of pipe and tube for oil and gas field and pipeline use.

Dr. Karl T. Compton, president of Massachusetts Institute of Technology, Cambridge, will be the guest speaker at the annual banquet of the 1948 Foundry Congress and Show of American Foundrymen's Association in Philadelphia, May 3-7, AFA Secretary-Treasurer William W. Maloney has announced.

The banquet, May 7, will climax the five-day meeting of the international technical society, expected to attract 20,000 castings industry executives, technologists and production men to a mammoth exhibit of foundry equipment and supplies in Philadelphia Convention Hall and a technical program featuring latest production and control techniques of the field.

Head of MIT since 1930, Dr. Compton has played a leading role in the application of science to the war effort and to reconversion and industrial recovery. He served on the War Resources Board, National Defense

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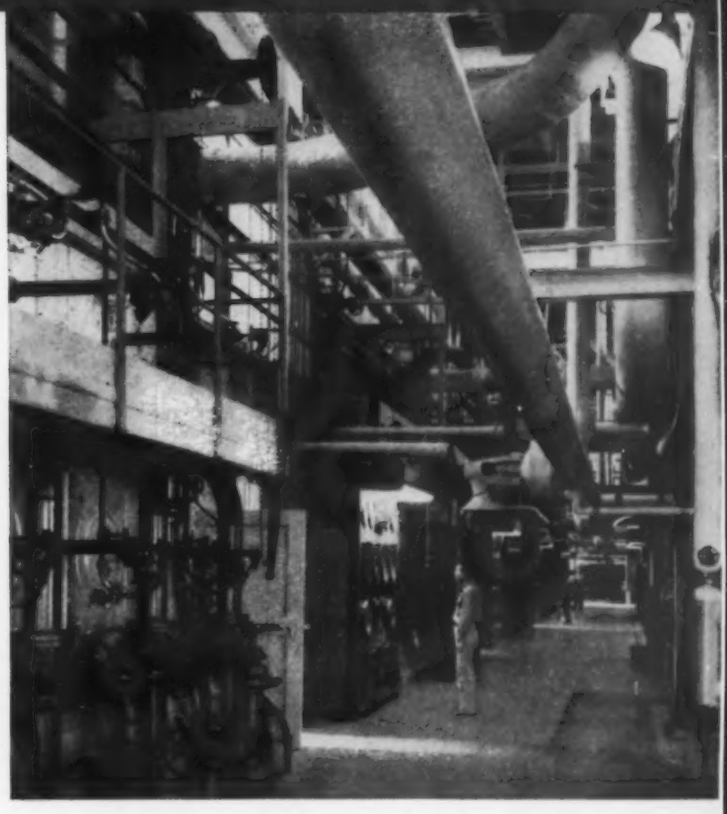

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Take a good look at your designed operating efficiency—and compare it with the *actual output* you are securing. Then call the nearest Dowell office for the facts and figures on *chemical* scale removal service.

Leading plants everywhere rely upon Dowell service—including some of the largest boiler installations in the nation. They tried Dowell service and found it rapid, safe and economical. They've seen Dowell engineers fill plant equipment with liquid solvents designed to dissolve and disintegrate scale and sludge—and they've seen the *results*. You'll make no mistake to follow their example—get the facts.

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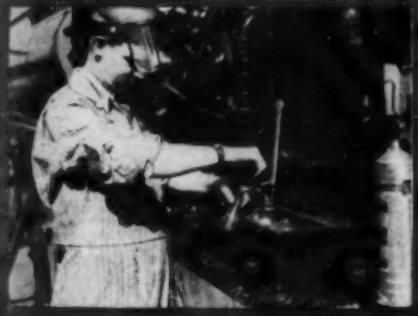

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Because of its versatile ability to cut many varied structural shapes, as well as solid or hollow bars in any sequence, without change of blade or setup, one machine can handle a volume of cutting that would otherwise require several separate shears or slow speed saws.

Consult Kling engineers regarding your metal cutting problems. State size of material to be cut. Bulletin No. 9200 giving full particulars and suggestions as to the type and size of saw will be mailed promptly. No obligation.

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Research Committee and with the Office of Scientific Research and Development, among numerous groups concerned with developments of national and international significance, and is at present a member of the National Council, Committee for the Marshall Plan to Aid European Recovery.

His topic at the dinner of the 10,000-member AFA will be, "Team Work of Hand and Brain."

Paul S. Strecker has been named assistant to the president of the E. W. Bliss Company. Mr. Strecker will continue to serve as personnel director of the company, with the additional responsibility of handling special administrative assignments.

Donald B. Gillies, after 55 years activity in mining and steel industries, has resigned as vice president and director of Republic Steel Corporation. He will, however, remain with Republic as an advisor and consultant on mining.

Mr. Gillies went to Cleveland in 1918 to accept the vice presidency of the Corrigan-McKinney Company, whose mining properties in Mexico he had managed since 1906. He was later made president of Corrigan-McKinney and in 1935 when that company consolidated with Republic was made a vice president of Republic.

Jules Muller has been appointed director of engineering of the E. W. Bliss Company. Mr. Muller will be responsible for the coordination of engineering between the various product divisions. **Arthur Schloz** will continue as chief engineer of the press division and **H. Farrington** will continue as chief engineer of the rolling mill division.

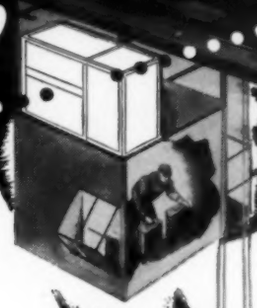
Robert S. Hayes became superintendent of the maintenance department at East works of American Rolling Mill Company, Middletown, Ohio. His first

ROBERT S. HAYES

connection with the company came in 1912 in the sheet mill department, where he advanced through various positions to become a roller helper in 1919. In 1924, he transferred to the sheet mill department at Armco's Ashland division in Ashland, Kentucky. At that plant, he advanced to the position of general foreman, and in 1931 returned to Middletown as general foreman of the blooming bar and strip mill. In 1936 he was appointed superintendent of the cold strip mill.

(*Please turn to page 141*)

CRANE CAB COOLING



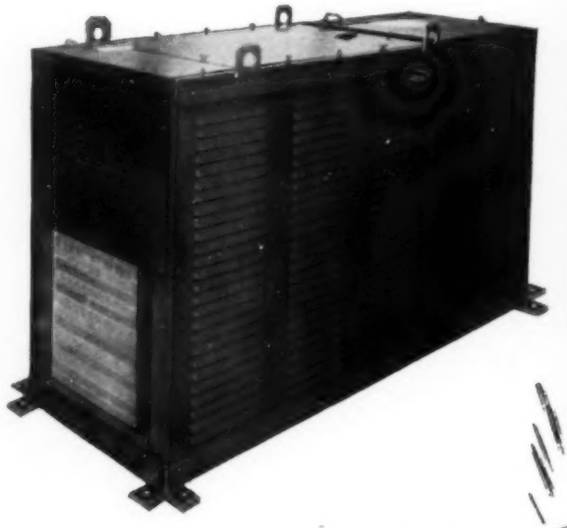
MEMO TO:
OPERATIONS DEPT.

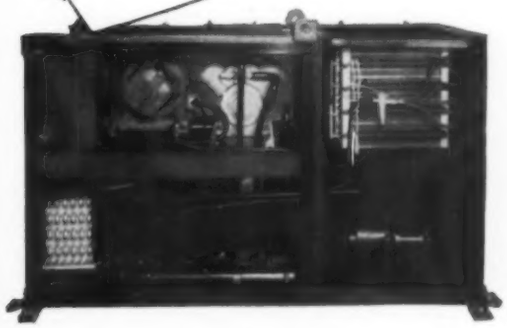
Wherever your hot metal crane operations involve working in excessive heat, obnoxious fumes, annoying odors, or dust, you can eliminate these hazards with **DRAVO CRANE CAB COOLERS.**

MEMO TO:
MAINTENANCE DEPT.

DRAVO CRANE CAB COOLERS are designed for mill duty under the most severe conditions.

Dravo Engineers have given long study to the maintenance problem and to the arrangement of equipment so that it is quickly accessible.





All panels are removable without tools. Moving parts and control panels are completely protected by the rigid frame.

These completely self-contained units provide clean, cooled, dehumified, decontaminated air to the crane cab in sufficient volume for any hot metal crane requirements.

DRAVO CRANE CAB COOLERS can be shipped from stock for use this summer. Each Dravo Crane Cab Cooler is equipped with units for winter heating as well as air conditioning.

DRAVO CRANE CAB COOLERS will operate safely, efficiently, and with minimum repairs, provided they receive the same periodic maintenance given to other electrical and mechanical equipment.

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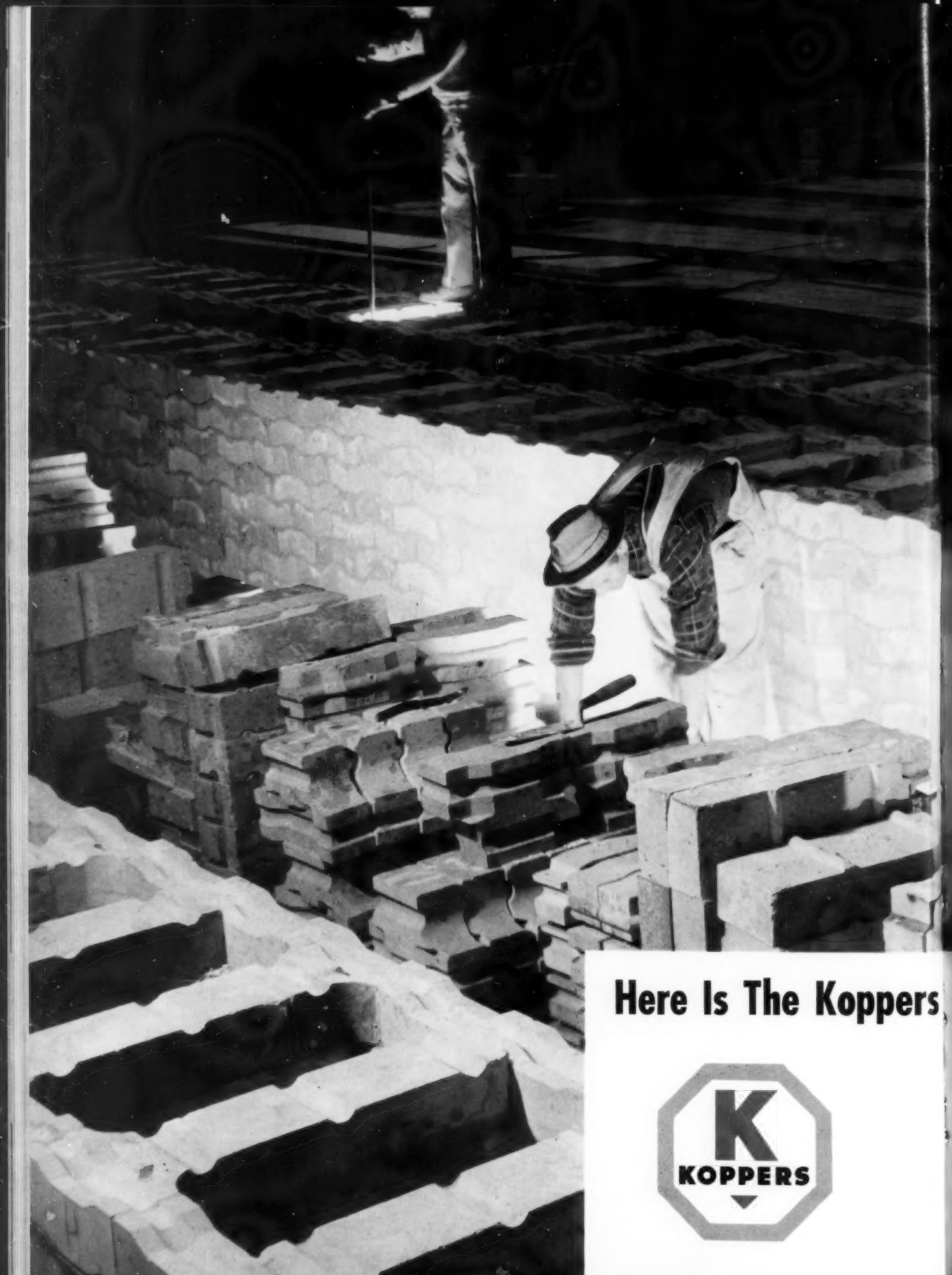
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NON-FLUID OIL

TRADE MARK REGISTERED

(*Continued from page 136*)

Carl W. Martin was appointed superintendent of the cold strip mill at American Rolling Mill Company's East works at Middletown, Ohio. He joined the Armco organization in 1913 as a member of the galvanizing department. After transferring to the blooming and

CARL W. MARTIN

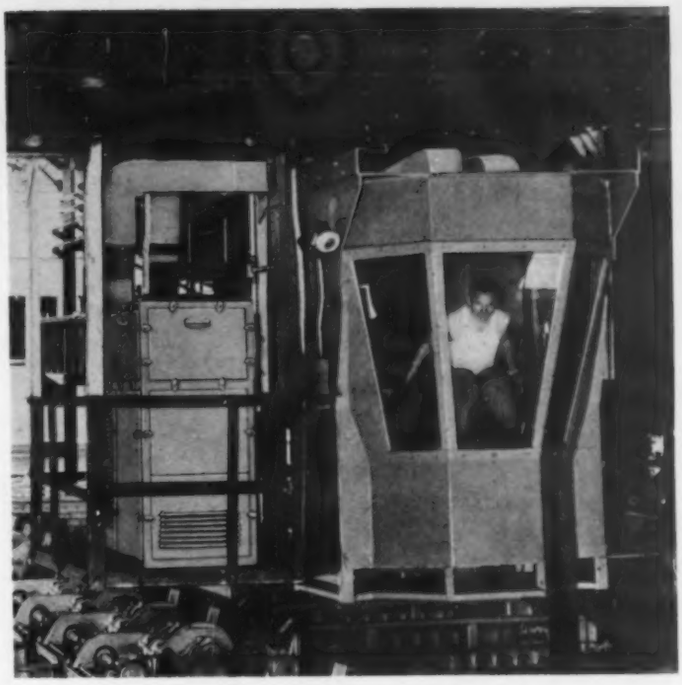
bar mill a short time later, he became a turn foreman, and in 1932, became general foreman of that department. He became a roll foreman in 1936 in the cold strip mill and general foreman in 1937. He was appointed acting superintendent of the cold strip processing department in 1944. In 1946 he was advanced to assistant to assistant general superintendent of the East works plant.

H. Merrill Bowman, who has been district sales manager of the Link-Belt office in Baltimore, Maryland, has been appointed assistant divisional sales manager for power transmission equipment, with headquarters at the company's Pershing Road plant in Chicago, Illinois.

Hugo E. Johnson, formerly research associate with the Carnegie-Illinois Steel Corporation, has been appointed to the administrative staff of Battelle Institute, Columbus, Ohio. Mr. Johnson will coordinate the interests of the various research groups at Battelle concerned with the metallurgy of iron and steel and act in a liaison capacity between the Institute and the iron and steel industries.

W. A. Reynolds has been appointed manager of the combined rotary pump and worm gear divisions for DeLaval Steam Turbine Company. Mr. Reynolds became associated with De Laval in 1932 when he was made manager of the pump division, which he still retains as part of his new position. Previously he was assistant to the vice president and general manager of the Hendry Machine Company, Torrington, Connecticut and sales engineer for the Dravo Corporation, Cleveland, Ohio. Mr. Reynolds is a graduate of Yale Sheffield Scientific School.

John A. Fellows was made assistant chief metallurgist at the American Brake Shoe Company's research center in Mahwah, New Jersey. He is resuming his association with the brake shoe firm after 2½ years



Soaking Pit Crane in Plant of a prominent steel company, equipped with Lintern Aire-Rectifier 145 AC-24.

The Only Crane Cab Conditioner Thoroughly Tested on Soaking Pit Applications

● In the illustration above the Lintern Aire-Rectifier was tested on the particular crane shown. It is the center crane of three.

After thorough testing, the plant installed Lintern Aire-Rectifiers on the other two cranes. All three gave satisfactory performance thoughout the past hot summer.

Lintern balanced refrigeration design prevents overloads in temperature as high as 170° F. This is the only crane cab conditioner which has had thorough testing on soaking pit applications. It is tried and proved. Only periodic inspection is required.

Ask for Bulletin AC 82147 describing the four new models now available for all types of mill and industrial cranes.

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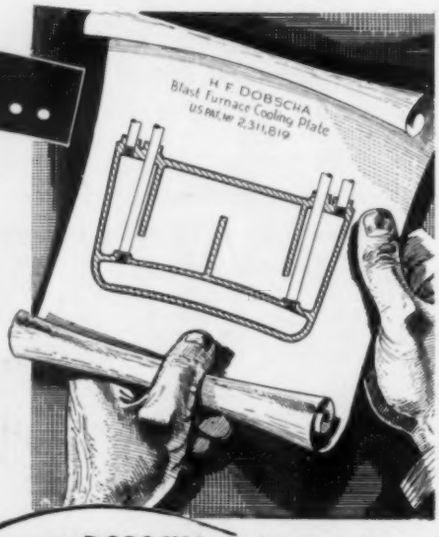
The Dobscha Plate is designed to allow sealing off of the "NOSE" compartment, in the event of "burning," without reducing the cooling area of the large volume "BUTT" compartment.

The design assures high velocity water travel through the "NOSE," thereby eliminating clogging due to bad water sediment.



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Falcon casts the Dobscha Plate vertically, without anchors or chaplets, "NOSE" down, so the densest metal is in the "NOSE" where needed.

Falcon installs the copper "Feed" and "Discharge" pipes to the nose compartment.

Falcon ships each Dobscha Plate in a special crate or cradle which protects these nose "Feed" and "Discharge" pipes in shipping and handling between the foundry and your furnace wall.

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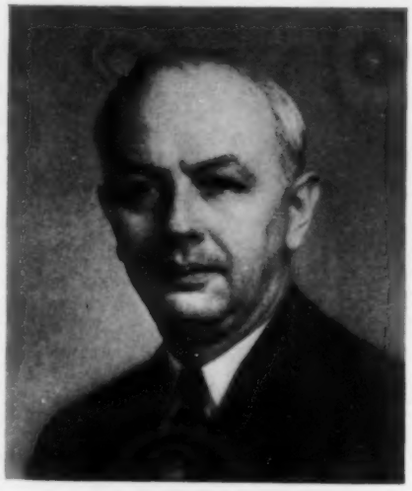
service in the atomic energy field and 1½ years service with Union Carbon and Carbide Company. Dr. Fellows first started with the Brake Shoe Company as assistant metallurgist in December 1937. A native of Greenfield, Massachusetts, he attended Williams College and the Massachusetts Institute of Technology from which he received the degree of doctor of science in 1942.

Wilbur Deutsch has been appointed general sales manager of Trabon Engineering Corporation, Cleveland, Ohio. Since joining the Trabon organization in 1936, he has served the company four years as sales



WILBUR DEUTSCH

engineer and erection superintendent and for five years was associated with F. R. Magill in Pittsburgh, Pennsylvania. During the past two years he has been in charge of sales and service for Trabon on the west coast.

William B. Wallis, president of Pittsburgh Lectromelt Furnace Corporation, has been nominated for president of the American Foundrymen's Association in 1948-49. Elections will be held at the annual business meeting during AFA's 52nd convention in Philadelphia, May 3-7.

Peter G. Holliday was appointed works manager of Pyle-National Company at Chicago, Illinois. Mr. Holliday was formerly vice president of Standard Cap and Seal Corporation, Chicago. After his graduation from the University of Minnesota with a degree in electrical engineering and business administration, he was employed in general research for the Minnesota Mining and Manufacturing Company, then in production engineering for General Motors.

G. F. Clipsham was appointed to the position of assistant to the president of Lincoln Electric Company. From 1935 until his recent return to the United States Mr. Clipsham was the president of Lincoln Electric Company, Welwyn Garden City, Herts, England. He went to England in 1935 to organize that company and during the past twelve years he has been an important influence in the development and the extension of the use of arc welding in the British Isles. Mr. Clipsham joined The Lincoln Electric Company in Cleveland in 1929 and was active until he went to England as welding engineer in various sections of the country.

Bernard Lester, assistant manager, headquarters,

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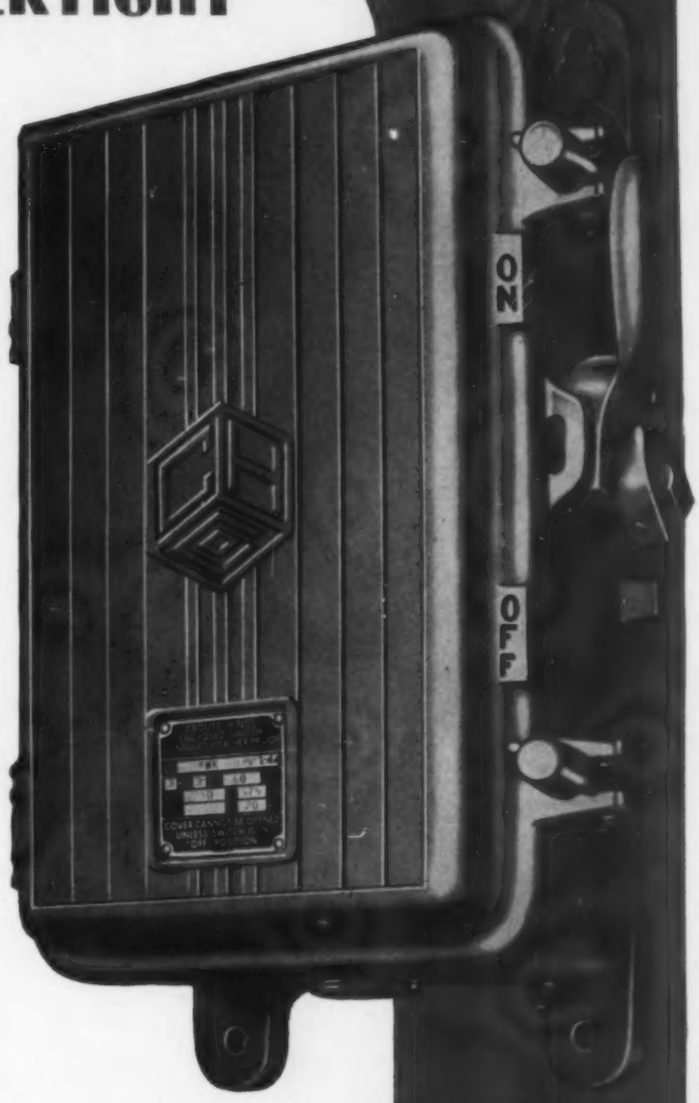
CONDULETS

**NEMA Types III and IV*



Safety. Positive interlock prevents opening the case unless switch is "off." Dead front switch is held in "off" position while case is open.

Switches. Quick make and break mechanism. Double break, reinforced, positive pressure-type blade and jaw construction. Positive pressure fuse clips. Combination solder or solderless wire lugs.

Cast metal case. Strong and durable. Four sturdy mounting feet. Many possible threaded hub arrangements for both vertical and horizontal conduit. Cover may be padlocked to prevent unauthorized entry. Operating handle may be padlocked "on" or "off."

Permanent lubrication in the threaded operating shaft bearings resists corrosion and prevents the entrance of dust and moisture.

Horsepower ratings. 2 through 50-H.P. 30, 60, 100 or 200-ampere. 230-575-volt A.C. 250-600-volt D.C.

Listed in Condulet Catalog 2500, Section 50, Page 20.

CONDULET is a coined word registered in the U. S. Patent Office. It designates a product made only by the Crouse-Hinds Company.

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FLOODLIGHTS
TRAFFIC SIGNALS
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THE WILLIAMS-HAGER FLANGED SILENT CHECK VALVE

is positive insurance against costly "Water Hammer"—built of materials to meet the requirements of any service, and pressures up to 6000 pounds. Write for new descriptive Bulletin WH-50 today.

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3076 PENNSYLVANIA AVE.
PITTSBURGH 12, PA.

industrial sales department, Westinghouse Electric Corporation, has retired after 43 years of service with Westinghouse.

In addition to his recent position, Mr. Lester has served as commercial engineer, manager of the small motor division, assistant industrial sales manager, manager of the resale department, and special representative since joining Westinghouse in 1905.

Following his retirement January 31, Mr. Lester will open his own consultation service in the sale and distribution of machinery and equipment for managers of medium-sized and small industrial equipment builders and suppliers. His service will emphasize distribution and sales.

F. D. Weatherholt was promoted to assistant industrial sales manager for Westinghouse Electric Corporation with headquarters at East Pittsburgh, Pennsylvania. A native of Cloverport, Kentucky, Mr. Weatherholt was graduated from the University of Kentucky in 1921 with the degree of bachelor of science in mechanical engineering. He came to Westinghouse that same year as a member of the graduate student course and upon completion of the course was assigned to small motor sales in East Springfield, Massachusetts.

In 1925 Mr. Weatherholt was transferred to the Albany, New York sales office and a year later was assigned to the New York City office. In 1940 he was named eastern resale manager, the position he held at the time of his new appointment. He served as a lieutenant commander in the Navy from 1942 through 1945.

W. S. Hall, formerly chief engineer, Chicago district of Carnegie-Illinois Steel Corporation, and **R. B. Gerhardt,** formerly chief engineer of construction of Bethlehem Steel Company, have become associated with United Engineers and Constructors, Inc., as consulting engineers. Mr. Hall will be resident in Chicago and Mr. Gerhardt will make his headquarters in Philadelphia.

C. W. Iams, Jr. was appointed assistant to executive vice president of Firth-Sterling Steel and Carbide Corporation. Mr. Iams is a graduate of Sheffield Scientific School, Yale University, 1933, and received a bachelor of science degree in industrial administration in engineering. His entire business life has been spent in the Pittsburgh area. He has had twelve years service with Carnegie-Illinois Steel Corporation in the industrial engineering department at Homestead, Clairton and Irvin. His position was plant industrial engineer at the latter two plants. For the past four years he has served as district industrial engineer, Pittsburgh district.

Lloyd R. Cooper has been named director of research for Heppenstall Company, Pittsburgh, Pennsylvania. Mr. Cooper received a bachelor of science degree in chemical engineering from Lehigh University in 1935. He then became a metallurgical observer at the Homestead works of Carnegie-Illinois Steel Corporation. He later worked in the U. S. Steel Corporation, Kearny, New Jersey research laboratory. Mr. Cooper joined the Heppenstall-Eddystone Corporation in 1942 as engineer of tests. He organized and supervised the test department and laboratory at this Eddystone, Pennsylvania, forgings plant built and operated by Heppenstall Company for the U. S. Navy. When the plant closed in 1944, Mr. Cooper moved to Pittsburgh to serve as research

Feeds, straightens and cuts steel rod at a speed of 125 ft. per minute on Timken® bearings

IN the Model No. 20-F Lewis Travel-Cut Shape Straightening and Cutting Machine, manufactured by The Lewis Machine Company of Cleveland, Ohio, a total of 70 Timken bearings are used on such vital parts as the feed and straightener rolls, the transmission drive, and the flywheel and cut-off mechanism drive.

Result: precise, trouble-free operation at a rate of 125 feet per minute, simplified lubrication, and efficient power transmission.

Due to the tapered construction of Timken bearings, they carry any combination of radial and thrust loads. Manufactured to extreme precision and finished to incredible smoothness, Timken roller bearings make friction practically negligible. Maximum load capacity is provided by the line contact between rolls and races. Timken bearings permit closures which retain lubricant. And since they're made of the finest bearing material ever developed—Timken fine alloy steel—they last the life of the machine.

Backed by 49 years of bearing research and development, Timken tapered roller bearings are first choice throughout all industry. No other bearing can bring you *all* the advantages you get with Timken bearings. Look for the trade-mark "Timken" on every bearing you use. The Timken Roller Bearing Company, Canton 6, Ohio.

TIMKEN BEARING EQUIPPED

This symbol on a product means its bearings are the best.

LEWIS TRAVEL-CUT relies on Timken bearings for long-time precision operation. 70 Timken bearings are used throughout the Model 20-F Travel-Cut Shape Straightening and Cutting Machine. This machine has a capacity of ⅞″ square or hex bars, and will handle flats up to 2″ wide.

WE MAKE OUR OWN STEEL

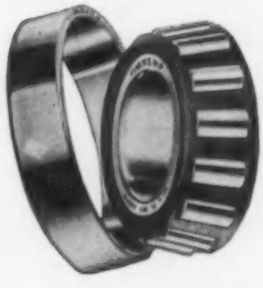
The special grade alloy steel which gives Timken bearings their strength and resistance to wear, is made in our own steel mills.

The Timken Roller Bearing Company is the acknowledged leader in: 1. advanced design; 2. precision manufacturing; 3. rigid quality control; 4. special analysis steels.

TIMKEN

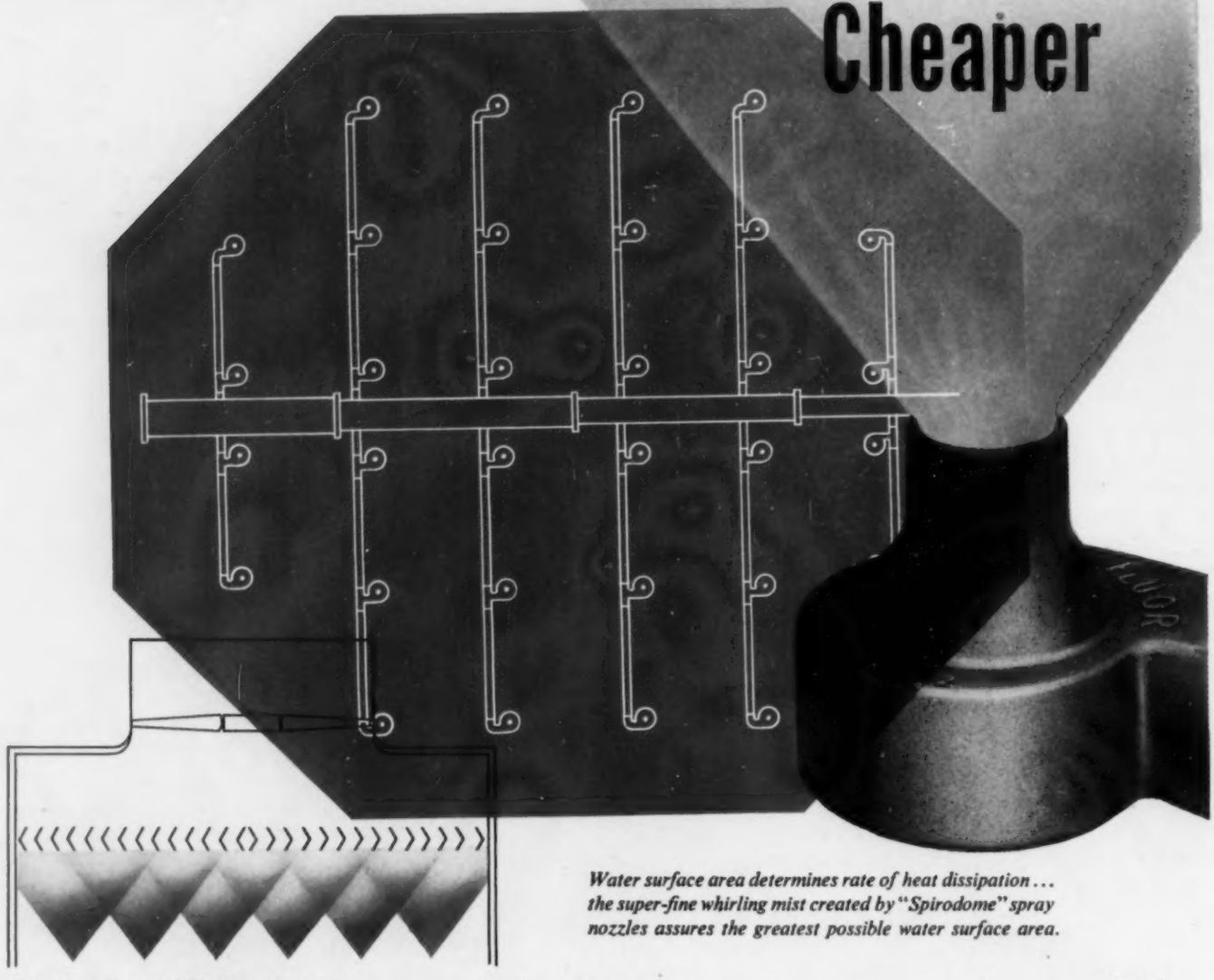
TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS



NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ◐ AND THRUST ⟷ LOADS OR ANY COMBINATION ✳

THOROUGH AIR-WATER MIXTURE = Colder Water Cheaper



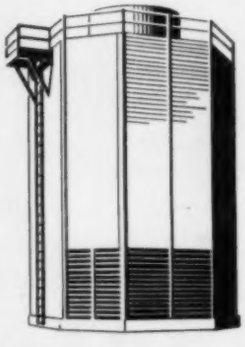
Water surface area determines rate of heat dissipation... the super-fine whirling mist created by "Spirodome" spray nozzles assures the greatest possible water surface area.

Cheaper? Yes, and here's why: The upspray distributing system in the Fluor "Counterflo" induced draft cooling tower, which incorporates the patented "Spirodome" Spray Nozzles, adds 8 or 9 feet of *unseen* cooling tower height. Here's how:

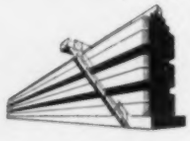
Water is sprayed 6 to 8 feet up into a spray chamber, where the drops are broken up into minute particles, and where the great heat load is flashed off before the drops even reach the first deck. Therefore the function of the decking is not to release the great bulk of the heat, but rather to cool the water to as close to wet bulb temperature as possible.

This system is a "must" where hot water is to be cooled, since the upper portion of the tower is at least twice as effective as the same tower with the usual flume and splash plate system.

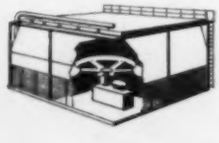
Yes...Fifty years' experience proves Fluor Cooling Towers will, year in and year out, deliver colder water cheaper.



Fluor "Counterflo" induced draft cooling towers, prefabricated in mass production, are available in multiple or single units in any required size or height.



Fluor areator atmospheric cooling towers are recommended where conditions make this type most practical.



The Fluor Fin-Fan cooling unit has a wide, economical range of utility throughout industry.

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PRODUCTS : *Cooling Equipment, Mufflers, Gas Cleaners, Pulsation Dampeners*

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metallurgist in the Heppenstall Company newly organized research department. He was appointed acting director of research in August, 1946.

Robert Urquhart was named general superintendent of Lorain, Ohio, works of National Tube Company. Mr. Urquhart, who since 1940 has been assistant general superintendent of the Homestead district works, Carnegie-Illinois Steel Corporation, succeeds **Bradford C. Colcord,** who has resigned. Mr. Urquhart, a native of Pittsburgh, is a graduate in both civil and metallurgical engineering of Carnegie Institute of Technology. He joined United States Steel as a draftsman at Homestead in 1914, progressing in various engineering and metallurgical positions to labor foreman at open hearth No. 3 in 1933. He was promoted to superintendent of that shop later in the same year. In 1936, he was appointed assistant superintendent of open hearths of the same plant. In 1937 he was promoted to superintendent of open hearths, the position he held until his appointment as assistant general superintendent of the entire Homestead district works in 1940.

ROBERT URQUHART

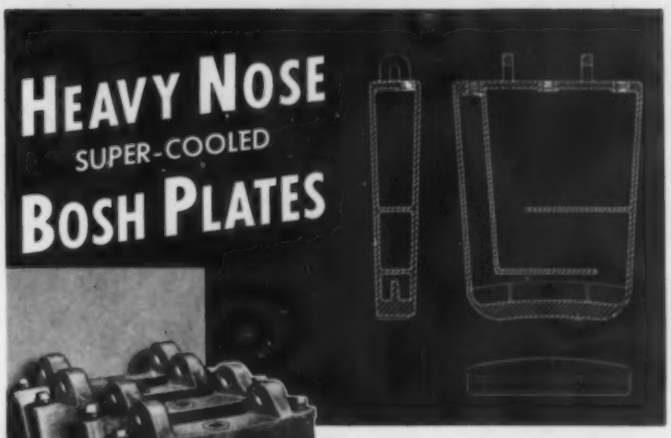
Robert W. Graham was appointed assistant general superintendent, Homestead district works, Carnegie-Illinois Steel Corporation. He succeeds Robert Urquhart, who is leaving to become superintendent of Lorain works of National Tube Company, another U. S. Steel subsidiary. Mr. Graham, a graduate of Carnegie Institute of Technology, was first employed at Homestead as a transfer operator in the 42-in. mill in 1925. He was made superintendent of the 100-in. mill in 1936 and assistant division superintendent of the plate and slab department in 1940.

In 1943, he was transferred to Geneva Steel Company as division superintendent in charge of rolling mills. He returned to Homestead in 1947 as assistant to the general superintendent, the position he held at the time of his present appointment.

WANTED — Experienced Sales Engineer

To represent midwestern electrical manufacturer in Pittsburgh area, including western Pennsylvania, part of Ohio, and West Virginia. Must be seasoned executive who can handle established district office. Electrical engineering graduate preferred. Practical experience in applying electric motors and controls or similar industrial lines is essential. Box 200, IRON AND STEEL ENGINEER, 1010 Empire Building, Pittsburgh 22, Pennsylvania.

HEAVY NOSE
SUPER-COOLED
BOSH PLATES



Designed especially for the tuyere zone where plates are most apt to burn. The inch thick copper nose is Super-Cooled by fins extending into the water chamber. Increased resistance to heat effects important reduction in plate losses.

Three year test shows 20 to 1 greater tonnage over ordinary plates.

This substantial saving was demonstrated on two furnaces under operating conditions as nearly similar as possible. The comparison was made between ordinary plates and Heavy Nose Plates in the tuyere zones of the two furnaces.

In addition to the great reduction in Bosh Plates per ton of iron, fewer shutdowns to change plates effected important savings.

To keep away from trouble and avoid needless costs, use Heavy Nose Super-Cooled Bosh Plates in the tuyere zone rows.

Made by Smeeth-Harwood specialized melting and molding techniques, assuring dense metal of measured thickness.

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Superior Blast Furnace Copper Castings *Exclusively.*

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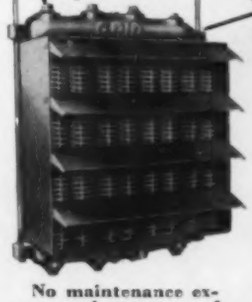
SO WHY THROW YOUR HEATING DOLLARS THROUGH THE ROOF!

GRID
UNIT HEATERS



No maintenance expense — but years of trouble-free heating service.

You wouldn't throw dollars out of the window, so why throw your heating dollars through the roof — yet you do that every time you buy a unit heater that fails to deliver warm air to the floor line — the working zone — where it is needed. Learn how and why GRID Unit Heaters with lower outlet temperatures and greater air delivery will save your heating dollars by delivering air to the working zone where heat is needed, with a result in saving in fuel consumption.

GRID heating sections are one piece construction high test cast iron, the metal for permanency . . . no electrolysis because there are no dissimilar metals used in GRID construction.

Write today for complete details, capacity tables—the story of GRID!

D. J. MURRAY MANUFACTURING CO.
WAUSAU, WISCONSIN

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WHY THIS Advertisement ?

We bought this space to tell about a pipe cleaning service for industry that means higher efficiency wherever any type of pipelines is used.

WHO SAYS It Does the Job ?

Many of the leading industrial organizations who are already using this service exclusively, say so. We shall be glad to send case histories and names on request.

WHAT IS IT We have to Offer ?

A pipe cleaning service that will cost you much less than you can do it yourself. Our service covers all types of pipes, and we use both mechanical and hydraulic cleaning systems. We are prepared at all times with special equipment and trained experts to meet any particular pipe cleaning problem you may have.

WHO CARES About this Service ?

Industries that want Clean Pipes. Clean pipelines mean fewer shutdowns, higher efficiency and money saved. Why not have one of our pipe cleaning engineers help you solve your pipe cleaning problems? Why not let us give you dollar and cents reasons why our service will profit you?

• *SERVICE* • *EQUIPMENT* • *KNOW HOW*

EASTERN PIPE MAINTENANCE COMPANY

507 TRIANGLE BUILDING

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DATE LINE DIARY...

January 2

▲ Ewan Clague, commissioner of labor statistics, predicted that living costs would climb even higher this year. However, he said there are a few signs that 1948 would be a depression year.

January 3

▲ Chairman W. Kingsland Macy, New York Republican, announced that a House Public Works Subcommittee will open hearings January 5 into an estimated $1 billion black market steel business. He stated that it has been estimated that between 4 and 12 per cent of the country's steel production finds its way into the black market.

▲ The sharp rise in United States production boosted world output of steel in 1947 to 151,400,000 tons, which is a gain of 26,100,000 tons from the previous year. The United States was the world's greatest producer and turned out almost 85,000,000 tons last year. Great Britain produced 14,200,000 tons, Germany produced about 3,000,000 tons compared with almost 22,000,000 in 1937. A definite figure for Russian production is not known, but in 1946 this production totaled about 21,500,000 tons.

January 4

▲ It was predicted by W. John Kenney, Undersecretary of the Navy, that the stockpiling of strategic materials would pick up speed during the coming year. Such stockpiling is contingent upon Congressional approval of appropriations.

January 5

▲ The portal-to-portal pay question arose again in the steel industry when approximately 40,000 individual workmen authorized attorney Charles J. Margiotti to recover for them what they claim is back pay owed them by the Carnegie-Illinois Steel Corporation, the National Tube Company, the Sharon Steel Corporation, and the Homestead Valve Manufacturing Company.

▲ The CIO United Steelworkers open their guns today with both barrels in their fight for a pay raise. Their claims are based on two basic arguments: the cost of living and inflation requires a pay raise in order that they may maintain their living standards and, secondly; the industry can afford to pay a wage increase and, as they state, profits are fantastic and are soaring to undreamed of heights. According to the union, the figures of the Bureau of Labor Statistics show that the price of steel rose 26.6 per cent in one year while the average hourly earnings of the steelworker rose 14.2 per cent.

▲ The operating rate of steel companies having 94 per cent of the steel capacity will be 97.9 per cent of capacity for the week beginning January 5, compared with 96.4 per cent one week ago.

January 6

▲ Seven all-time steel production records were achieved in 1947 at three Pittsburgh district plants of the United States Steel. Among these records are: Homestead Works set a new record of 3,968,390 tons of steel ingots, National Works produced a record 253,750 tons of pipe, and Irvin Works produced a record 1,774,832 tons on their 80 inch hot strip mill.

▲ During the coming year, numerous articles in household appliance field may run in short supply but there is a pronounced drift towards a balance of supply and demand. In some items, a balanced market appears to be at hand. A shortage of steel, however, still remains the most important material problem in the appliance industry.

January 7

▲ Net profits of the Lukens Steel Company and its subsidiaries for the fiscal year ending November 1, 1947, were equivalent to $8.92 a share in contrast with $0.002 a share in 1946.

▲ The Association of American Railroads stated that the railroads set a new record for moving coal in 1947 when the coal tonnage total was 520,000,000 tons.

▲ President Truman asked the steel industry to invest $50,000,000,000 over the next few years to improve and expand the productive facilities we need for a growing future.

▲ A Senate investigating committee is ready to report that independent steel users will be forced to the wall if heavy steel exports are made under the Marshall Plan.

January 8

▲ Economist Leo Cherne predicted that retail prices will rise by as much as 10 per cent and wages by 8 to 10 per cent in 1948.

▲ Four-dollar advances in pig iron were announced by two Buffalo district producers, to bring their prices in line with those of the Hanna Furnace Corporation, which made similar increases a few days ago.

▲ A new peacetime record was set for the 1947 season on the Great Lakes when freighters moved 176,648,110 tons of iron ore, coal, limestone, and grain.

January 9

▲ Freight car producers during December reached a peak of 9,803 cars which is more than triple that of the previous January.

January 10

▲ William L. Batt, president of SKF Industries, Incorporated, stated that the $16,000,000,000 which American manufacturers invested in new factories and equipment in 1947 will bring cheerful news to consumers in 1948. He further predicted that the business outlook for the new year was encouraging.

January 11

▲ The interim 20 per cent freight rate increase that became effective a few days ago may result in changes in marketing areas for many materials and products. Each freight rate increase has a tendency to intensify the concentration of sales near the mills in order to avoid absorbing freight on distant area deliveries.

January 12

▲ John C. Virden, Cleveland industrialist has been named special assistant secretary of commerce to head up the Office of Industry Co-operation, which is the name under which the steel allocation agency will function. Details and mechanics of operation are being worked out rapidly.

▲ Hearings on the Federal Trade Commission's complaint charging the steel industry with "conspiracy and collusive action to fix and maintain delivered price quotations and restrain competition" opened today in the FTC building in Washington.

▲ The operating rate of steel companies having 94 per cent capacity will be 98.7 per cent of capacity for the week beginning January 12 compared with 97.9 per cent one week ago.

January 13

▲ Non-farm employment rose to an all-time high of nearly 51,000,000 in December, topping the previous month by 400,000. Total employment shrunk

to a little below 58,000,000 which was a net decline of 600,000 because of the usual winter slack in farming.

January 14

▲ Benjamin J. Fairless, president of the United States Steel Corporation, stated that as of January 1, 1948, U. S. Steel had a rated annual capacity for the production of steel ingots and castings of 31,226,200 net tons. This capacity represents a net increase of 3,431,200 tons or 12.3 per cent since January 1, 1940

▲ The Federal Trade Commission has asked 101 major steel producing firms to submit price lists on 72 basic steel products for the last several years.

January 15

▲ The Koppers Company will acquire all the outstanding stock of Missouri-Illinois Furnaces, Inc., an Illinois corporation formed last October 1 to purchase the government-owned blast furnace and coke plant at Granite City, Illinois.

January 16

▲ The marketed production of natural gas was 4,030,605 cubic feet in 1946, which is 3 per cent above the 1945 peak of 3,918,686 cubic feet. The Appalachian region reversed its declining trend with an increase of 25 billion cubic feet. Total consumption increased 3 per cent above the 1945 record to 4,012,930 cubic feet.

January 19

▲ Official steel production in 1947 was a total of 84,787,501 net tons of ingots and steel castings. This tonnage exceeds the 1946 output by more than 18,000,000 tons. Steel capacity for 1948 is listed as 94,233,640 ingot tons vs 91,241,250 ingot tons in 1947. Blast furnace capacity for 1948 is listed at 67,438,930 net tons vs 65,709,200 net tons for 1947. Coke oven capacity is rated at 62,505,840 tons for 1948 vs 60,280,590 net tons in 1947.

▲ The operating rate of steel capacities having 94 per cent of the steel capacity will be 96.1 per cent of capacity for the week beginning January 19.

January 20

▲ President C. M. White of Republic Steel Corporation in a telegram to the WAA Administrator, requested that the Cleveland blast furnace be leased to the Republic Steel Corporation and the coke oven plant be sold to the Republic Steel Corporation without delay. This $28,000,000 surplus blast furnace and coke plant is being sought by the Tucker Corporation, a Chicago automobile concern.

January 21

▲ Youngstown Sheet and Tube Company announced that they expect to spend $50,000,000 on an improvement program by July 1, 1949. The major items in this program are the purchase of the Carter Coal Company, financing part of an iron ore concentration plant in Minnesota, rebuilding No. 1 blast furnace at Indiana Harbor and increasing its capacity from 800 to 1400 tons of iron a day, erecting 75 new by-product coke ovens at Indiana Harbor plus other improvements and modernization.

January 23

▲ Lukens Steel Company announced that an increase of $6.00 per net ton for carbon steel and alloy steel plates will be effective on all shipments made after January 26.

January 26

▲ The general opinion expressed at the 20th annual convention of the Institute of Scrap Iron and Steel held last week in Chicago was that the scrap supply will continue tight. The demand for 1948 will probably exceed that of 1947.

▲ Twenty-two California congressmen united in pleas to President Truman and the Reconstruction Finance Corporation for action which would enable Henry J. Kaiser to expand the Fontana steel plant and to repay his Fontana debt in full.

▲ The operating rate of steel companies having 94 per cent of the steel capacity will be 95.2 per cent of capacity for the week beginning January 26.

▲ Allegheny Ludlum Steel Corporation reported that earnings for 1947 were $4.66 per common share, compared with $5.12 per share in 1946.

January 27

▲ Effective March 1, a new drastic export program was announced by the Department of Commerce. After that date, every shipment to Europe, Russia and a dozen other areas, will require a license. The areas covered by these shipments receive about 50 per cent of United States exports. Exporters, in general, are against the controls.

▲ The highest profit in history was reported by the Jones and Laughlin Steel Corporation for 1947. Net profit was $8.45 a share compared with $3.79 a share in 1946. The above figures are given after preferred dividend requirements.

▲ United States Steel Corporation announced that profits for 1947 were $11.66 a share compared with $7.29 a share in 1946.

▲ Measured in terms of employment, manufacturing in Allegheny County expanded by more than 48 per cent in the seven-year period from 1939 through 1946. Ninety companies reported plans for immediate expansion, and 27 of these involve new plants or additions to plants, and 63 involve modernization or acquisition of new equipment.

January 28

▲ The world is expanding its sources of uranium, the new mineral vital to the atomic age. Extensive new deposits have just been announced in Burma and the Union of South Africa. At the present time, the largest proven pitchblende deposits (most common source of uranium) is found in the Belgian Congo.

▲ The National Industrial Conference Board stated that the cost of government has gone up far more since 1939 than the cost of food, clothing and other essentials. During this period, Federal tax revenue per person increased 677 per cent and this was exclusive of Federal payroll taxes. The rising cost of Federal government is also only one part of the high tax picture, and state and other local government collections have increased markedly in the past few years.

▲ The Federal Reserve Board reported that industrial production declined slightly in December from the postwar record of November, and output of the nation's factories and mines was listed on its production index at 91 per cent above the 1935-1939 average. Contrary to the general decline, activity in durable goods industries continued to advance.

▲ Wheeling Steel Company reported record net earnings for 1947 of $15.15 per common share as compared with $6.25 per common share for the previous year.

▲ Net sales of the Inland Steel Company for 1947 were 44.7 per cent over the previous calendar year, and the net income for 1947 was $6.10 per share compared with $3.18 for the previous year.

January 29

▲ The Youngstown Sheet and Tube Company in a preliminary report listed the 1947 net profit as $26,299,923 compared with $14,254,905 for 1946.

January 30

▲ Secretary of Commerce asked the steel industry to allocate steel voluntarily to four industries of great national importance. He listed the following industries: freight cars, farm machinery, oil equipment, and home building.

▲ Industry opposition to the allocation program including the projected voluntary setup and the controls requested by President Truman, began to be felt. One effect was to slow down development. The farm equipment industry refused to commit itself to this program when it met in Washington on January 27. The spokesmen declared that they wished to work with the government but they were not sure that the program being set up was desirable in all respects.

January 31

▲ The Kaiser-Frazer Corporation announced the purchase of a blast furnace and coke ovens in Utah from the War Assets Administration for $1,150,000. The plants which were originally built at a cost of about $13,000,000 and which have been operated for the government by the United States Steel Corporation, have a capacity of 300,000 tons of pig iron a year. This blast furnace was moved during the war from Joliet, Illinois to Ironton, which is near Provo, Utah. It includes 500 beehive coke ovens.

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(*Continued from page 126*)

short labor market. In view of the national car shortage, the more rapid turnover of cars by the consumer permits quicker return of cars to the producer. This aids in keeping production at peak levels in the mines and industry." Approximately 75 coal cars daily are unloaded at the Inland plant.

Under normal conditions, the shakeout, requiring only one or two men to operate, can empty a 50 or 70-ton hopper car containing bulk materials such as coal, ore, coke or limestone in two to five minutes. Manually, the same operation requires a crew of eight to eleven men from fifteen minutes to more than one hour for the unloading of each car, he added.

The five-ton shakeout is placed astride the sides of the car to be unloaded by a hoist. In operation, it sets up rhythmic harmonics within itself — more than 1000 impulses a minute — which are transmitted by contact to the car and its entire contents. Since no men are required to be in or on the car during the operation, safety for the unloading crew also is greatly increased.

EDGE CONTROL INCREASES SLITTING SPEED 300%

By L. LEMON

Reliance Electric and Engineering Company

▲ When, during the installation of a new 60-in. slitting line at the Reynolds Alloys Company's plant at Listerhill, Alabama, it was decided to step up the operating speed from 500 fpm to 1500 fpm, engineers of the Reliance Electric and Engineering Company who had supplied the electronically-operated type of edge control had an opportunity to test the ability of the mechanism to function satisfactorily at speeds never before approached.

Earlier application by Reliance of electronic photo cells to edge control apparatus ordinarily activated by guide-roll reactors had been successful in boosting top operating speeds from 600 fpm to 1000 fpm. The Listerhill installation, however, represented the first attempt to operate at a speed substantially above these figures.

The coil carriage mechanism is mounted on a sliding base which is shifted back and forth by means of a screw driven through a 15 to 1 ratio worm gear, the high speed shaft of which is coupled to a 5 hp 900 rpm, 230 volt, shunt wound motor.

Electronic photo cells installed on the entry side of the line detect any shifting of the strip and send a signal to the power source which feeds the shifting motor. This "signal" is introduced into a relatively simple phase-shift bridge circuit which in turn shifts the phase relationship of grid to anode of a pair of thyratron tubes, allowing them to pass more or less current, depending on that relationship.

This current is used to excite one field of a small two-fold generator. Excitation of the other field is from the main 250 volt plant service.

When the bridge circuit is balanced, the output voltage of the rectifier is 50 per cent of maximum. This voltage is impressed on the control field which has a nominal field strength twice that of the reference field. With the bridge balanced (50 per cent rectifier output), the strength of the two fields is equal and opposed, one to the other, and the generator armature output is substantially zero. The "shifter" motor, therefore, remains stationary.

As the position of the strip changes due to camber, the bridge circuit becomes unbalanced and the rectifier output rises or falls depending on the direction of the camber. The balance between the two generator fields is correspondingly upset and a voltage is generated which causes the shifter motor to operate in one direction or the other, depending upon the polarity of the current fed it. As the strip comes into alignment, the bridge circut is again balanced, the generated voltage drops to zero and the shifter motor stops.

The position of balance can be given a vernier adjustment by changing the rheostat in the generator reference field. Shifting of the balance point may also be accomplished by resistor in the bridge circuit. An automatic-manual selector is provided so that the control can be manually operated, if desired, or when the overtravel limit switches have stopped the motion of the pay-off.

HEWITT-ROBINS' UNIT WILL DO CONTRACTING

▲ A new division, Robins Engineers, has been organized by Hewitt-Robins, Inc. to handle the contracting phases in the design, engineering and installation of complete material handling and processing plants. The 50 engineers assigned to the new division formerly were associated with the concern's Robins Conveyors division, pioneer company in the manufacture and installation of heavy duty belt conveyors.

BRIDGE TO YIELD 8000 TONS OF SCRAP

▲ Over 8000 tons of much needed steel scrap commenced moving to U. S. Steel furnaces when American Bridge Company started to dismantle the old Wabash Railroad Bridge, crossing the Monongahela River at Pittsburgh, Pennsylvania, for the Pittsburgh and West Virginia Railway Company on February 15. The scrap will go to Carnegie-Illinois Steel Corporation plants in the Pittsburgh district.

INTRODUCE NEW LINE OF WIRE ROPE HOISTS

▲ Yale and Towne Manufacturing Company has announced a new line of low-cost, low-capacity, wire rope hoists, designed to bring the advantages of cable and drum hoisting to a wider industry group. The new light-duty hoist will be known as the "Load King," and will be available in ¼, ½, and 1-ton capacities. The frame of the portable hoist is a heavy, one-piece, ribbed-steel casting, constructed for use with lug, plain trolley, motor trolley, or winch-type mounting.

The quick-lifting hoist is equipped with a large-diameter drum with machine-cut grooves for guiding the cable as it winds. The drum has sufficient capacity to provide for full standard lift without overlapping of

The hoist frame is constructed for use with lug, trolley, or winch-type mounting.

cable. The specially-designed reversing-type motor is rated to operate under constant service with full load without destructive overheating.

REFRACTORY BRICK FOR STEEL FURNACES

▲ Harbison-Walker Refractories Company announces the shortening of the name of its basic refractory brick "H-W Improved Metalkase" to "Metalkase." The company emphasizes the fact that there is no change in quality of the product, which is a steel jacketed basic refractory brick for basic open-hearth and electric steel furnaces. Metalkase bricks are produced exclusively by Harbison-Walker.

Applications include: front walls, side walls, back walls, end walls, skewbacks, roof shoulders. In a typical front wall construction, steel plates are used at every fourth course (vertical) of Metalkase refractories. Steel bars, tack-welded to these plates, are welded to the solid buckstays, thus forming a rigid, tightly bonded wall.

These refractories have been in general use for many years, and have been responsible for increasing service life as much as ten times in many applications and for substantial cost savings in furnace operations.

GRIDDING PLAIN BEARINGS RAISES LOAD-LIFE RATIO

▲ In the past, various types of bearings have provided one or more desirable properties, but no one bearing had been found which combined all of them. Improvement in one direction meant the sacrifice of some other quality. Other factors also complicate the picture: for example, the theory of lubrication seldom works out in actual practice.

In any commercial engine, conditions are never as stable as in the laboratory. The fluid film of oil is often so thin in some pressure areas that is must be measured in molecules. Actual metal-to-metal contact frequently exists, especially during starting and stopping periods.

In general, babbitts are known as the best bearing materials within their strength limit. They readily embed dirt and grit and work well with all common types of shaft material. They will endure insufficient or intermittent lubrication and considerable distortion. In short, babbitts' strong points are conformability, embedability, and seizure resistance.

But babbitts fail when stressed or pounded too heavily. They simply do not have the strength and fatigue resistance to stand up in many modern high speed, heavy-duty applications. So newer materials were tried, such as copper-lead steel back bearings, and various types of bronze. All have their advantages, but none have the tolerance of babbitts.

Bronze backing proved to have some advantages over steel. Its high thermal conductivity quickly transmits heat and equalizes the temperature over the entire bearing to prevent local cracking. Good bronze also provides superior conformability without fatiguing.

Gridding the centrifugally cast lead-tin bronze, to combine its advantages with those of babbitt, was the next logical step. It was here that National Bearing engineers developed their simple mechanical method of gridding that at last makes gridded bearings practical for mass production.

The result is an almost ideal combination of good bearing properties: the gridded area provides conformability in a strong bronze bearing, plus embedability equal to that of the babbitts.

Present applications of gridded bearings are main and connecting rods of heavily-loaded diesel engines and similar heavy-duty service. They are now operating under loads of over 3500 psi projected area, with shafts as low as 160 Brinell hardness. Minimum depth of grids is .008 in.; minimum area of babbitt is 40 per cent. The required balance of conformability and embedability for individual applications is obtained by controlling the proportion of land (the parent bronze) and the babbitt-filled grid.

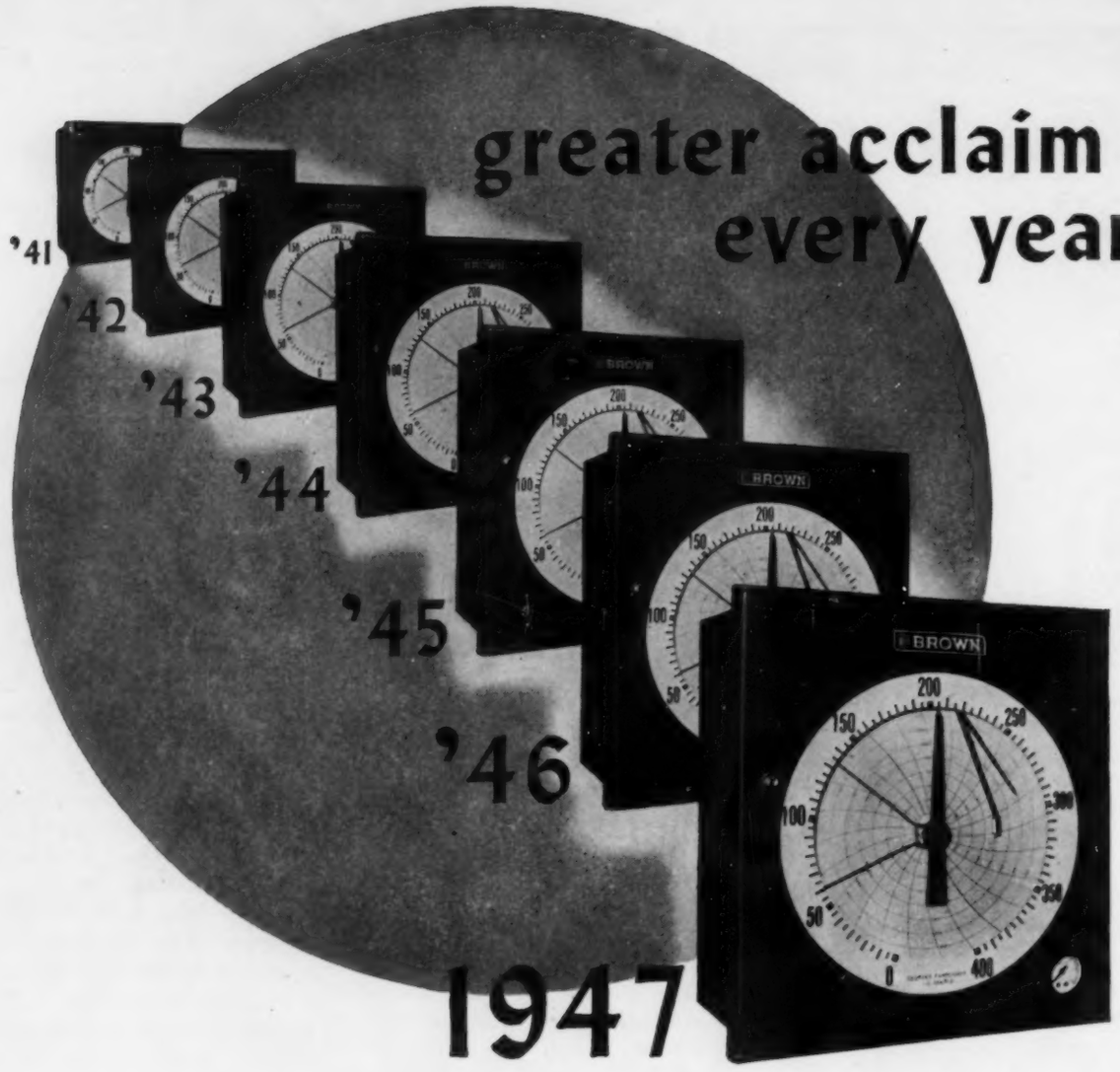
BEARING RATINGS UPPED ONE-FOURTH

▲ Timken Roller Bearing Company recently announced the results of an exhaustive 10-year study in their physical laboratory and in the field — a 25 per cent increase in the radial and thrust load carrying capacities of Timken's complete line of tapered roller bearings.

This increase is based on several factors including improved alloy steels made specifically for anti-friction bearings, better metallurgical control, more accurate manufacturing equipment, greatly improved surface finishes and more accurate inspection methods. The bearing performance continually checked by a battery of fatigue life testing machines in Timken's physical laboratory plus the observed performance of bearings operating in all types of automotive, industrial and railway equipment fully justify the increased ratings. This increase in capacity ratings will enable design engineers throughout all industry to effect important savings in new designs not only in bearing costs but in surrounding mechanisms as well.

NEW THICKNESS GAGE INCREASES SHEET OUTPUT

▲ In answer to the thickness gaging problems in modern high speed rolling mills, Westinghouse has developed an x-ray thickness gage offering unique advantages of (1) no contact with the material being gaged, (2) ready access



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to areas never before gaged, and (3) high sensitivity and accuracy.

Present applications to sheet metals indicate that the gage will increase output of prime sheet, solve some operating problems, and eliminate marring of the surface of the materials being gaged. As a quality control instrument, this equipment is expected to find application in the thickness control of hot metal and glass sheet, aluminum foil, plastics, paper, and other sheet and strip materials.

Employing two x-ray sources at right angles with one photomultiplier-fluorescent screen pick-up unit at the apex, the gage compares the controlled material to a correct sample. The two x-ray sources emit x-rays 180 degrees out of phase.

Positive and negative readings showing the thickness differential above or below the standard sample are shown on an instrument within view of the operator. The gage automatically rejects off-gage material in flying shear applications or controls the screw downs to maintain uniform thickness in material coming from a cold mill. One model now installed on a tinplate line is designed for thickness of sheet from .005 to .050 in., but the basic equipment is the same for other applications. The indicator needle on the gage instrument will react to a variation of 0.0001 of an in. in a 0.1 in. thick sheet.

It is unaffected by fluttering of the sheet, surface coatings such as lacquer, or by atmospheres heavy with palm oil, steam, and water. Normally mounted on a slide so that it can be removed from the pass line, it can also be arranged to rove across the sheet.

CARNEGIE-ILLINOIS JUNKS STEAM ENGINE

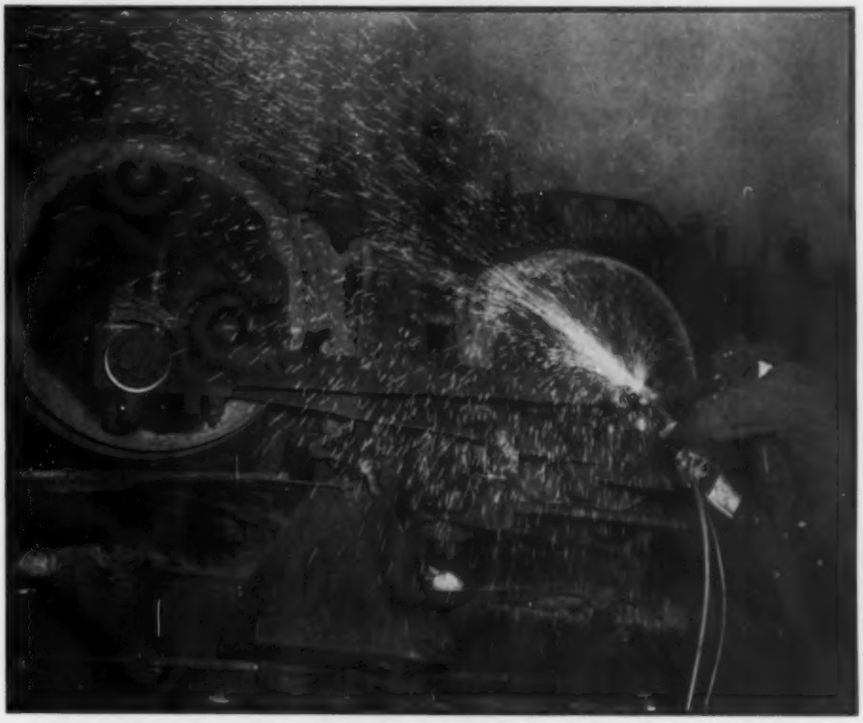
▲ Another smoke-belching old "dinky" engine chugged to the scrap heap recently at Ohio works of Carnegie-Illinois Steel Corporation, marking another step in U. S. Steel's displacement of outmoded railroad equipment with diesel locomotives.

Departure of old "19" ended a 25-year friendship between man and machine. Adam Hohvart, railroading veteran with 46 years' service at the plant, took the throttle on her maiden run in 1922 and has been in the cab of the powerful, little engine ever since. Now he's operating one of the new diesels.

No. 19 is the seventh "dinky" to be scrapped since the first narrow gage diesel was put into use at the Carnegie-Illinois plant at Youngstown, Ohio, just before the war.

The plant now has nine diesels in service, five of them being 50-ton, 350 horsepower locomotives with twin engines, one in the front and one in back. The four others are 35-ton, single-engine equipment.

In addition, the plant now has in use four 115-ton diesels operating on standard gage tracks, along with four older steam engines.



Wheels upturned, a smoke-belching old "dinky" engine ends up as scrap iron at Ohio works of Carnegie-Illinois Steel Corporation in Youngstown, Ohio. This marks another step ahead in the steel company's replacement of outmoded railroad equipment with sleek new diesel locomotives.

IDLER DEVELOPMENT LENGTHENS BELT LIFE

▲ A new adjustable troughing idler that materially increases the life of conveyor belts is announced by Koppers Company, Inc. The inventor is P. J. Connors of Koppers' engineering and construction division, who has assigned the patent to his company.

Outer inclined pulleys are adjustable from slightly above the horizontal up to an angle of 25 degrees. All idler pulleys are located in the same vertical plane and the adjustment of the outer pulleys is accomplished in a manner which maintains a constant gap between the ends of the horizontal and inclined pulleys. This gap is kept to a minimum to eliminate any possibility of the belt being damaged due to creasing or pinching at such points.

With this adjustable type of idler the accent is on increased conveyor belt life, as conveyor belts in general are usually quite expensive. With this new design it is possible to practically tailor-make the idler installation to fit the conveyor belt. Some materials do not require as deep a trough as that given by the standard 20 degree troughed idlers, and this Koppers improved idler design can be used in such cases to provide any suitable depth of trough.

This adjustable idler design is ideally suited for use at locations on conveyors where any inclined belt changes to a horizontal path. At present this change in belt direction is accomplished by use of a flat bend pulley, or by a number of 20 degree idlers arranged to form a vertical curve. Spillage often occurs when a conveyor belt flattens out while passing over a bend pulley, and the belt is affected to some extent by the sudden change from a troughed section to flat and vice versa. When standard 20 degree troughed idlers are used on a vertical curve, the conveyor belt is unduly

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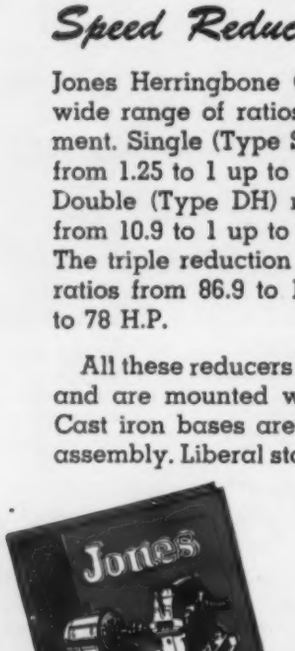
All these reducers have heat treated gears, ground shafts and are mounted with anti-friction bearings throughout. Cast iron bases are available for all variations of motor assembly. Liberal stocks are carried to facilitate shipments.



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stretched at the edges when passing over these idlers, due to the deep trough. With this new idler design a suitable number of adjustable idlers can be used for form a vertical curve and provide the shallowest depth of trough necessary to retain the material without spill. This shallow trough will also eliminate excessive belt stretch at the edges.

The use of a suitable number of these adjustable idlers, at the feed and discharge ends of belt conveyors, will allow the belt to be troughed or flattened gradually. This will reduce the strain on the belt due to the elimination of the abrupt distortion of belt when entering or leaving the idlers. This is especially pronounced at discharge ends of conveyors where belt stresses are usually the highest.

Book Reviews

▲ "Magnetic Control of Industrial Motors" by George W. Heumann, of the control engineering division, General Electric Company, provides exhaustive coverage of electric motor performance, characteristics of control devices, and functions of commonly-used control circuits. Unlike existing books in this field, which have been written largely from the standpoint of the design engineer, Mr. Huemann places primary stress on user's requirements. Whereas the designer concentrated on a device, a circuit, or a mechanical arrangement of parts — the plant or operating engineer must have a knowledge of what control equipment can accomplish, what is required of a particular drive system, and what performance can be expected of various types of motors.

This book supplies the fundamental information needed, as well as up-to-date coverage of such subjects as amplidyne control and a-c hoist controls. Written by an experienced engineer, and presenting the best information currently available in its specialized field, it should prove invaluable as a working reference.

The book, published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, New York, consists of 589 pages, 365 figures, cloth 5½ by 9 in., price $7.50.

▲ The fifth edition of "Steel and its Heat Treatment," prepared by the Metallurgical Staff of the Batelle Memorial Institute, has just been published by John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, New York. This edition is printed in two volumes, Volume I, "Principles," 489 pages, 5⅞ by 9 inches, 262 figures, cloth, $6.00; Volume II, "Tools, Processes, and Control," 293 pages, 5⅞ by 9 inches, 118 figures, cloth, $4.00. The amazing growth in the understanding of heat-treating phenomena and consequently in the ability to control results have made a major revision imperative. Volume I presents definitions, terminology and the fundamental concepts necessary for an understanding of heat treatment. This entire volume emphasizes the modern principles underlying the various types of heat treatment, whether of carbon or alloy steel. Volume II covers the practical application of the principles outlined in Volume I, and discusses the tools of heat treatment. This volume also discusses the various methods of preventing cracking and distortion, preparation of steel, the relation of heat treatment to welding and the heat treatment of cast iron.

▲ The 1947 compilation of ASTM Standards on Electrical Insulating Materials aggregates 580 pages, and gives in their latest form the some 90 specifications and tests covering a wide range of materials in this field. There are groups of specifications or tests on the following: Insulating varnishes, paints and lacquers, 7 tests; Plates, sheets, tubes, rods, and molded materials, 9 specifications, 28 tests; Mineral oils for electrical insulation, 9 tests; Ceramic products (glass, porcelain, steatite), 2 specifications, 4 tests; Solid filling and treating compounds, 2 tests; Insulating fabrics, 2 specifications, 3 tests; Insulating papers, 3 tests; Mica products, 1 specification, 3 tests; Electrical tests, 6 tests; Rubber products, 4 specifications; Textile materials, 10 specifications; Miscellaneous, servicing units, conditioning, pH value test, 2 specifications, 3 tests. In addition to these standards there is an appendix discussing the significance of tests of these materials, and information on the scope and personnel of ASTM Committee D-9, which sponsors the publication. A detailed index completes the book which is available in paper cover from ASTM, 1916 Race Street, Philadelphia 3, Pennsylvania at $4.00 per copy.

▲ "NEMA Standards for Fans, Publication No. 47-128" — These standards provide practical information concerning test, rating, performance and manufacturing of alternating- and direct-current electric fans of the desk and bracket type, pedestal type, ceiling type, ventilating type (made from desk or bracket fan parts) and air circulators. They represent general practice in the industry, promote production economies, and assist users in the proper selection of electric fans. 8½×11½, 14 pages, $0.50, NEMA, 155 East 44th Street, New York 17, New York.

▲ The 1947 edition of the compilation of ASTM Standards on Copper and Copper Alloys which include cast and wrought materials, electrical conductors, and non-ferrous metals used in copper alloys, aggregates 480 pages.

The section on copper and copper-alloy wire and cable for electrical conductors has 15 specifications for a variety of wire, rods, etc. Following this there are 12 widely used standards covering various non-ferrous metals, such as slab zinc, silicon copper, nickel, lead and others. Then follow sections on the various copper and copper alloy products as follows:

a. Plate, sheet, and strip
b. Wire, rods, bars and shapes
c. Pipe and tubes
d. Alloys for sand castings
e. Alloy die casting

Finally, there is an extensive section of 140 pages covering methods of tests including the expansion test, mercurous nitrate test, tension hardness and others. Copies of this book in heavy paper cover may be procured from ASTM, 1916 Race Street, Philadelphia 3, Pennsylvania, at $4.00 each.

▲ "Practical Descriptive Geometry," by S. E. Rusinoff, price $3.50, published by the American Technical Society, Chicago, Illinois, develops the principles and procedures of descriptive geometry in the situations in which they will be used in modern industry. A few of the features of this new publication are: 1. Time-saving methods that will save days in getting an idea off the drafting board. 2. Representative problems from a wide variety of fields. 3. Elimination of unimportant steps. 4. Industry tested methods of presenting the engineering shops with drawings that save them hours of time and labor.

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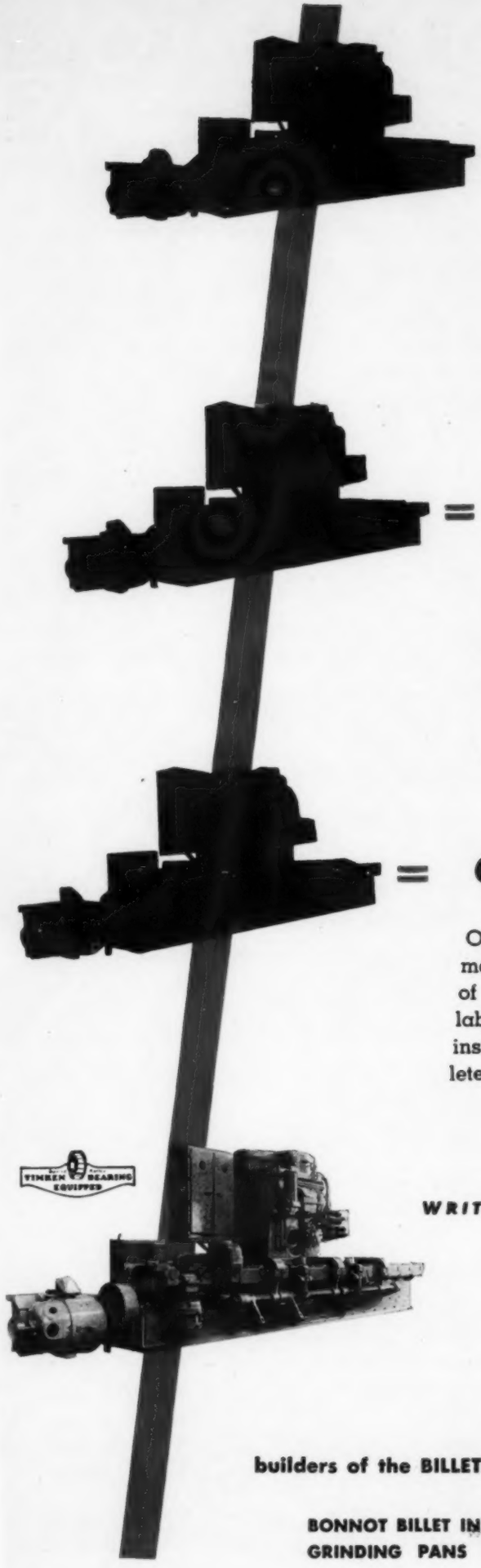

= 100% Scrap Recovery

The Billeteer saves every ounce of steel removed from billets . . . classified according to analysis . . . ready for the charging box. One mill, operating four Billeteers, saves over six tons of scrap a day . . . more than 2000 tons a year. And all this over and above the fact that the Billeteer permits salvage of billets so badly scarred that hand-chipping or flame conditioning would be impractical.

= Greater Speed

One Billeteer does the work of 10 manual chippers, and does it better. Operation of the Billeteer is simple . . . operator can be quickly trained. Designed and built for long, trouble-free service, the Billeteer keeps thoroughly cleaned billets moving rapidly and steadily from the billet shed . . . sets a more profitable pace throughout your plant.

= Greater Economy

One plant using Billeteers saved $892,528 (over manual-chipping) in conditioning 714,022 net tons of billets. By increasing billet output, cutting labor costs, increasing worker efficiency, and insuring steady, dependable operation, the Billeteer can effect impressive savings in your plant.

TIMKEN BEARING EQUIPPED

WRITE TODAY FOR FULL INFORMATION

Engineered

FOR LOWER OPERATING COSTS

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builders of the BILLETEER • THE BONNOT COMPANY • CANTON 2, OHIO

BONNOT BILLET INSPECTION TABLES • CHARGING TABLES • COLD SAWS
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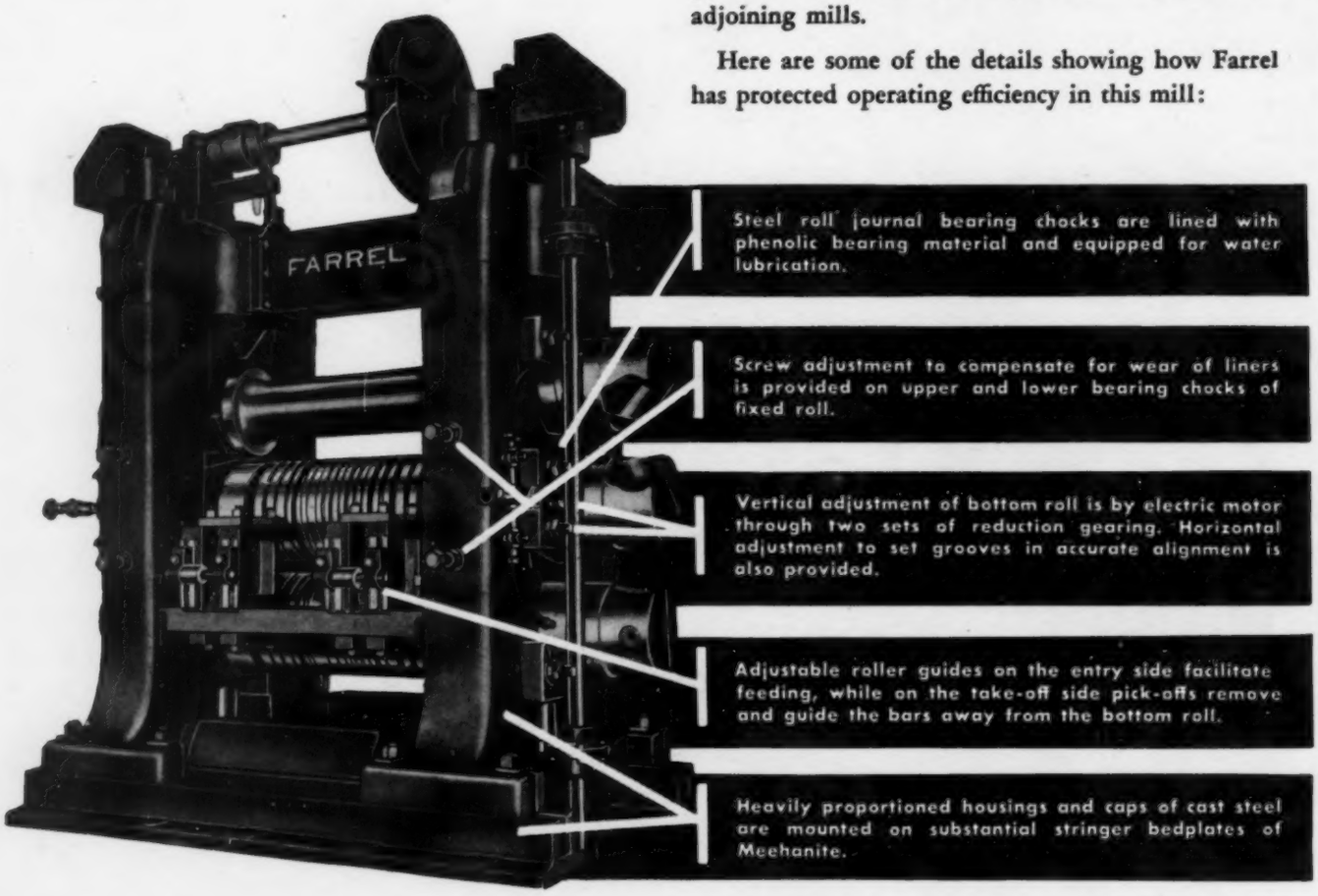
How Farrel FORTIFIES EFFICIENCY in this "EDGE CORRECTING" MILL

By design and construction Farrel gives this 18" x 49" mill the ability to maintain accuracy and efficiency despite continuous heavy duty edging bar stock from several flat pass mills.

This key unit in the rolling mill line has forged steel rolls with accurately matched grooves to handle various sizes of rectangular bar for successive passes. The mill maintains the width gauge of the bar and edges it to the form of the roll groove bottoms, correcting any edge irregularities developed by the various flat passes. The top roll acts only as a driving shaft for adjoining mills.

Here are some of the details showing how Farrel has protected operating efficiency in this mill:


FARREL
Steel roll journal bearing chocks are lined with phenolic bearing material and equipped for water lubrication.
Screw adjustment to compensate for wear of liners is provided on upper and lower bearing chocks of fixed roll.
Vertical adjustment of bottom roll is by electric motor through two sets of reduction gearing. Horizontal adjustment to set grooves in accurate alignment is also provided.
Adjustable roller guides on the entry side facilitate feeding, while on the take-off side pick-offs remove and guide the bars away from the bottom roll.
Heavily proportioned housings and caps of cast steel are mounted on substantial stringer bedplates of Meehanite.

FARREL ROLLING MILL MACHINERY

Rolls	Mill Pinions
Rolling Mills	Pinion Stands
Rod Mill Tables and Manipulating Equipment	Gear Drives of any Capacity
Universal Mill Spindles	Flexible Couplings
Rod Coilers	Roll Grinding Machines
Gears	Roll Calipers
	Lead Presses for Pipe or Rod

Complete information on this or other Farrel rolling mill equipment will be sent promptly, on request.

FB-347

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONN.

Plants: Ansonia and Derby, Conn., Buffalo, N. Y.
Sales Offices Ansonia, Buffalo, New York, Boston, Pittsburgh, Akron, Chicago, Los Angeles, Tulsa, Houston

Farrel-Birmingham

The New

NORTH AMERICAN

Soft-Seat

ATMOSPHERIC REGULATORS

● Series 18 North American Atmospheric Regulators are designed especially for single valve control of premix gas burner systems and incorporate the new feature of a soft seat for tight shutoff when the demand for gas flow ceases. Users will find the tight shutoff feature quite advantageous in that close control can be realized at low gas flow.

● Single valve control can be used with non-premix systems by connecting the vent on the Series 18 Atmospheric Regulator to the air line downstream from the control valve. The regulator responds quickly to very slight changes in impulse line pressure.

● When the Series 18 Atmospheric Regulator is used, both premix and non-premix systems are assured proportional air-gas ratios over the entire capacity range of the regulator.

THE NORTH AMERICAN MANUFACTURING COMPANY
GAS or OIL COMBUSTION EQUIPMENT ● OFFICES in PRINCIPAL CITIES
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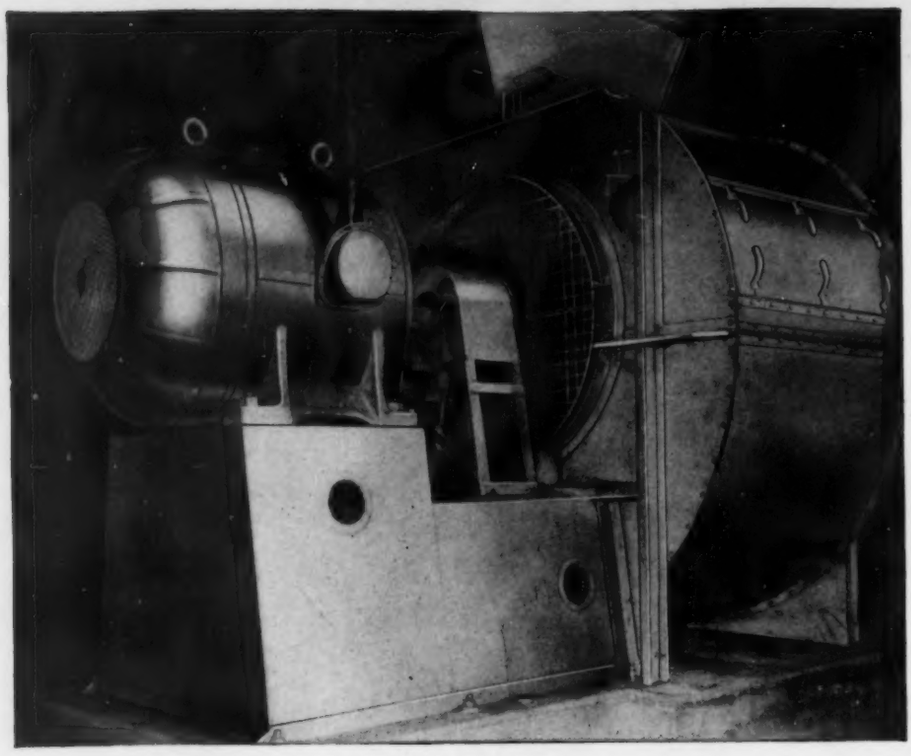

FANS by "Buffalo"

MILL MOTOR COOLING

With 'Round the Clock Dependability

"Buffalo" FANS

• Mill men know that fans for motor cooling have a tough job — heat, continuous operation at high pressures, and not too much maintenance attention.

That's why Buffalo builds husky fans for this service. Heavy plate housings, built like stoker fans, oversize shaft and bearings and good heavy rotors are needed for this job.

Fans like the one shown here are giving efficient trouble-free service on many mill motors ventilating installations.

EQUIPMENT FOR

- VENTILATING
- HEATING
- COMFORT COOLING
- PROCESS COOLING
- AIR TEMPERING
- AIR WASHING
- EXHAUSTING
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CUTTING AIR COSTS IN EVERY BRANCH OF INDUSTRY

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With costs as high as they are, choosing a cable is more important than ever. And no one can afford a cable *unless it protects* against unnecessary repairs . . . against removal . . . against replacement.

Building true value into cable has been Okonite's business since 1878. In the company's seven decades, Okonite engineers have pioneered advance after advance in insulation, in cable design, in types of assemblies, in methods of manufacture which contribute to long-lived, failure-free operation.

. . . FOR INDUSTRIAL PLANTS

are specific types of Okonite wires and cables custom-built for hot spots, for wet locations, for extreme flexibility, for indoor and outdoor use above or below ground — in fact, for use wherever insulated conductors are needed regardless of the external difficulties.

What goes into an Okonite cable to make it do a better job . . . what tests it must pass . . . what care is taken to control its electrical characteristics — all this and other data are found in 32-page Research Bulletin 101. For a copy, address The Okonite Company, Passaic, N. J.

*The lifetime cost of a cable rather than its first cost is the only true measure. Okonite wires and cables, built to stand up better and longer, can offset high installation costs.

6286

OKONITE insulated wires and cables

THE BEST CABLE IS YOUR BEST POLICY

As the white outline indicates, a standard unit of more than double the frame size would be required to do the work of Speedaire.

Latest in a distinguished series, SPEEDAIRE saves $407

FOR 25 years, this plastics manufacturer has used Cleveland Worm Gear Speed Reducers. On the left you see one of our earliest standardized worm units, driving a rod extruder. In the center background is a current standard reducer, and in the foreground is a Speedaire.

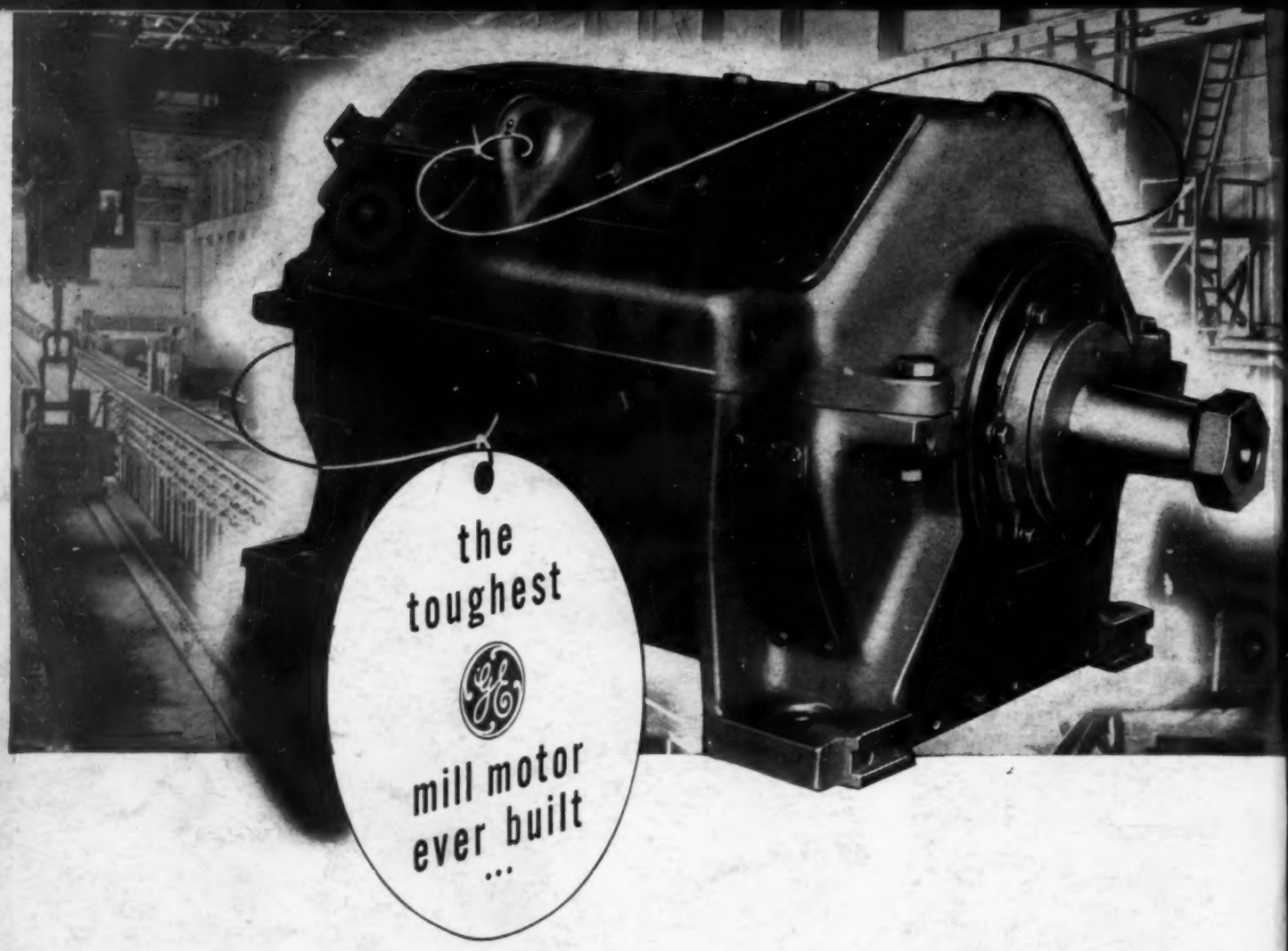
All three Cleveland units do similar jobs, driving extruders. Yet compared to the standard model of equivalent capacity, Speedaire occupies less than half as much space, reduces weight by 700 pounds, and saves $407.00 in initial cost.

Speedaire is Cleveland's new fan-cooled worm-gear speed reducer. Because it is fan-cooled, Speedaire will do more work —will deliver up to *double the horsepower* of standard worm units of equal frame size, at usual motor speeds. It can be installed economically on many applications where other types have been used heretofore—giving you the advantages of a compact right-angle drive. Speedaire gives the same long, trouble-free service characteristic of all Clevelands.

Send for Catalog 300 for a full description. The Cleveland Worm & Gear Company, 3278 East 80th Street, Cleveland 4, O.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.

CLEVELAND
Worm Gear
Speed Reducers



...gives you more hp per frame size!

Now you can get a General Electric d-c mill motor—the MD-600—with more horsepower in the same AISE frame size. For example, a 25-hp motor is now available in the No. 6 frame where formerly a No. 8 frame was required. AISE mounting dimensions and safety factors remain unchanged—you simply get a lighter, smaller motor with all the efficiency and power of the next highest frame size.

Several important features of the MD-600 motor make this space and weight saving possible. Better use of available space, particularly in mounting the bearings, is one. Improved glass insulation permits larger current-carrying conductors. The MD-600 has a more efficient ventilating system. Finally, a full set of commutating poles on the entire line of motors has extended the sparkless-commutation zone. For complete technical information on how the MD-600 motor can help you cut costs in your mill, write for Bulletin GEA-4654. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

THE MD-600 . . . FIRST IN ITS FIELD
for these 8 reasons!

- Cast-steel frame with heavier cross-section
- Solid cylindrical-roller-type bearings
- Universal frame for all types of enclosures
- Better commutation at all loads and speeds
- Lighter weight, shorter length
- Higher maximum safe speeds
- Better armature insulati
- Low Wk^2, improved efficiency, less heating

MD-600 MILL MOTORS

GENERAL ELECTRIC

659-47